39

TL2-39

INSTRUCTION BOOK

For

NAVY MODEL TDH
RADIO TELEPHONE AND TELEGRAPH TRANSMITTING EQUIPMENT

Power Output 3000 Watts — 2,000 kc. to 12,000 kc.
Power Output 2500 Watts — 12,000 kc. to 18,100 kc.

Frequency Range 2000 Kc. to 18,000 Kc.

0281-038-0000

NAVSHIPS 95331

MANUFACTURED FOR
U. S. NAVY DEPARTMENT, BUREAU OF SHIPS

By

COLLINS RADIO COMPANY
CEDAR RAPIDS, IOWA

Contract: NXss-5515

Dated: 16 November 1942

ADDENDA NO. 1

Refer to page 23.

The following tubes should have been included under **1.2.3. Tube Complement:**

NAVY TYPE COL-23351 REMOTE CONTROL UNIT

Symbol Designation	Navy Type Number	Circuit Function	Unit
V401	6SJ7	Audio Amplifier	Remote Control
V402	6SN7GT	Audio Amp-Disabling Amp.	Remote Control
V403	6X5GT	Rectifier	Remote Control

12-29-44

personnel engaged in the installation, operation and maintenance of this equipment or similar equipment is urged to become familiar with the following rules both in theory and in the practical application thereof. it is the duty of every radioman to be prepared to give adequate first aid and thereby prevent avoidable loss of life. your own life may depend on this.

electric shock first-aid treatment

Regard electrical apparatus generally, and especially all current-carrying parts, as dangerous, irrespective of voltage. Exercise great care in handling, and avoid broad contacts such as are made by standing on a metal deck or in water. Dangerous contact may result through lessened resistance when the skin and clothing are wet with perspiration. Contact with damp metal surfaces—decks, bulkheads, guns, machinery—may allow the current to ground through the moist skin and body. Electric shock is due to current passing through the body—current actually passing—irrespective of the voltage. A pressure as low as 110 volts has caused death. Current passing through the body in the region of the heart is especially dangerous. In using electric breast drills avoid the possibility of a ground. Usually electric shock does not kill instantly. Life can often be saved even though breathing has stopped.

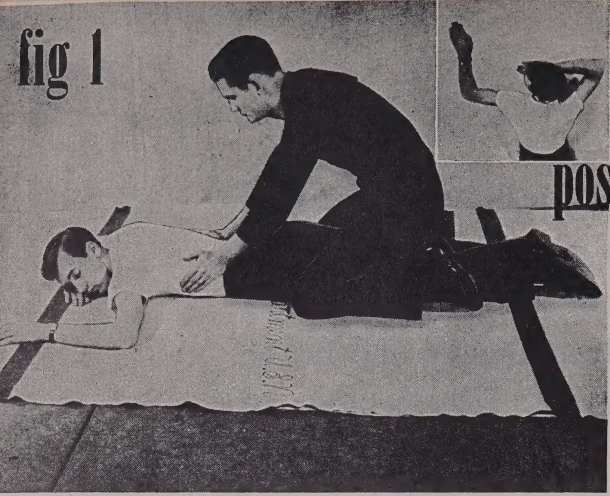
1. *Free the victim from the circuit immediately*—Use a dry nonconductor (rubber gloves, clothing, rope, board) to move either the victim or the wire. Beware of using metal or moist material. Shut off the current. If necessary to cut a live wire, use an ax or hatchet with a dry wooden handle; turn your face away from the electrical flash.

2. *Attend instantly to the victim's breathing*—Begin resuscitation at once on the spot. Do not stop to loosen clothing; every moment counts.

resuscitation by the prone pressure method of artificial respiration for gas asphyxiation, electric shock and drowning

Waste no time. When the patient is removed from the water, gas, smoke, or electric contact, get to work at once with your own hands. Send for the medical officer or nearest physician. No reliance should be placed upon any special mechanical apparatus, as it is frequently out of order and often is not available when most needed. The patient's mouth should be cleared of any obstruction such as chewing gum or tobacco, false teeth, or mucus, so that there is no interference with the entrance and escape of air.

fig 1

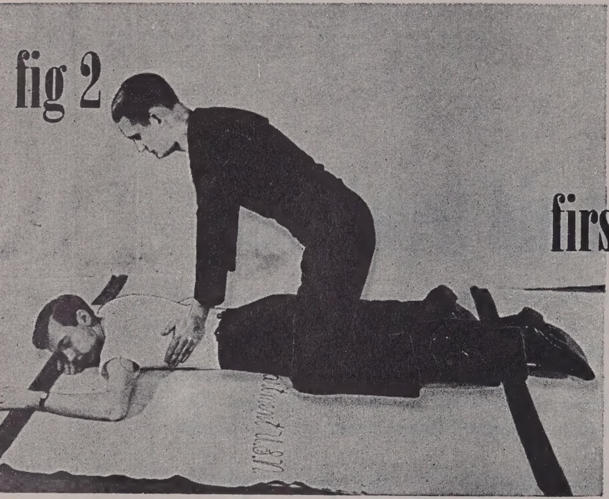


position

1 Lay the patient on his belly, one arm extended directly overhead, the other arm bent at elbow and with the face turned outward and resting on hand and forearm, so that the nose and mouth are free for breathing. (See Inset fig. 1.)

2 Kneel straddling over the patient's thighs with your knees placed at such a distance from the hip bones as will allow you to assume the position shown in Figure 1. Place the palms of the hands on the small of the back with fingers resting on the ribs, the little finger just touching the lowest rib, with the thumb and fingers in a natural position, and the tips of the fingers just out of sight. (See fig. 1.)

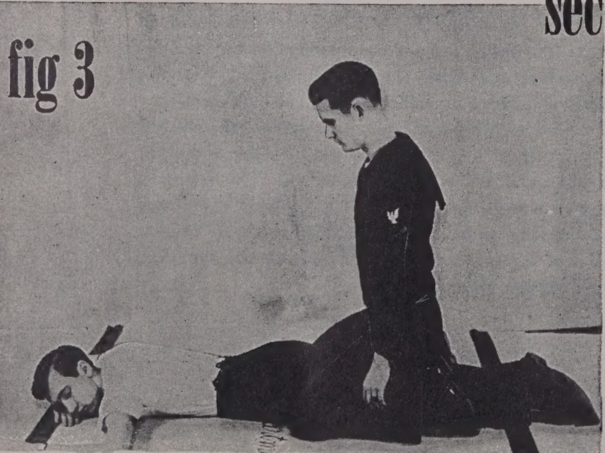
fig 2



first movement

3 With arms held straight, swing forward slowly, so that the weight of your body is gradually brought to bear upon the patient. The shoulder should be directly over the heel of the hand at the end of the forward swing. (See fig. 2.) Do not bend your elbows. This operation should take about two seconds.

fig 3



second movement

4 Now immediately swing backward, so as to remove the pressure completely. (See fig. 3.)

5 After two seconds, swing forward again. Thus repeat deliberately twelve to fifteen times a minute the double movement of compression and release, a complete respiration in four or five seconds.

6 Continue artificial respiration without interruption until natural breathing is restored. Do not get discouraged at the slow results that sometimes happen when resuscitating the apparently drowned. Efforts often have to be continued a long time before signs of life are apparent. Do not discontinue the efforts until certain that all chance is lost. Sometimes, even after several hours work, recovery takes place.

7 As soon as this artificial respiration has been started and while it is being continued, an assistant should loosen any tight clothing about the patient's neck, chest, or waist. *To keep the patient warm during artificial respiration is most important and it may be necessary to cover him with blankets and work through them, as well as to apply hot-water bottles, hot bricks, etc.* Do not give any liquids whatever by mouth until the patient is fully conscious.

8 To avoid strain on the heart when the patient revives, he should be kept lying down and not allowed to stand or sit up. If the doctor has not arrived by the time the patient has revived, he should be given some stimulant, such as one teaspoonful of aromatic spirits of ammonia in a small glass of water or a hot drink of coffee or tea, etc. Continue to keep the patient warm and at rest.

9 Resuscitation should be carried on at the nearest possible point to where the patient received his injuries. As a general rule he should not be moved from this point until he is breathing normally of his own volition and then moved only in a lying position. Should it be necessary, due to extreme weather condition, etc., to move the patient before he is breathing normally, resuscitation should be carried on during the time that he is being moved.

10 A brief return of natural respiration is not a certain indication for stopping the resuscitation. Not infrequently the patient, after a temporary recovery of respiration, stops breathing again. The patient must be watched, and if natural breathing stops, artificial respiration should be resumed at once.

11 In carrying out resuscitation it may be necessary to change the operator. This change must be made without losing the rhythm of respiration. The relief operator should kneel behind the one giving the artificial respiration and at the end of the movement, the operator crawls forward while the relief takes his place. By this procedure no confusion results at the time of change of operator and a regular rhythm is kept up.

practice in the performance of artificial respiration on a voluntary subject should be obtained by everyone

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Power Output 3000 Watts — 2,000 kc. to 12,000 kc.
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By

COLLINS RADIO COMPANY
CEDAR RAPIDS, IOWA

Contract: NXss-5515

Dated: 16 November 1942

OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE EQUIPMENT WITH HIGH VOLTAGE SUPPLY ON. DO NOT DEPEND UPON DOOR SWITCHES OR INTERLOCKS FOR PROTECTION BUT ALWAYS SHUT DOWN MOTOR GENERATORS OR OTHER ASSOCIATED POWER EQUIPMENT AND OPEN MAIN SWITCH IN POWER SUPPLY CIRCUIT. UNDER CERTAIN CONDITIONS DANGEROUS POTENTIALS MAY EXIST IN CIRCUITS WITH POWER CONTROLS IN THE OFF POSITION DUE TO CHARGES RETAINED BY CAPACITORS, ETC. TO AVOID CASUALTIES ALWAYS DISCHARGE AND GROUND CIRCUITS PRIOR TO TOUCHING THEM.

WARNING

Since the use of high voltages which are dangerous to human life is necessary to the successful operation of the radio transmitting equipment covered by these instructions, certain reasonable precautionary measures must be carefully observed by the operating personnel during the adjustment and operation of the equipment.

The major portions of the equipment are within shielding enclosures, provided where necessary with access doors which are generally fitted with safety interlock switches which act to shut off dangerous voltages within the enclosures when the access doors are open.

It should be borne in mind that interlocks are provided only on normal access doors on certain major units and therefore side, back or top screens, commutator covers, if removed, will not cause interlocks to function and will thereby allow access to circuits carrying voltages dangerous to human life.

While every practicable safety precaution has been incorporated in this equipment, the following rules must be strictly observed:

KEEP AWAY FROM LIVE CIRCUITS

Under no circumstances should any person be permitted to reach within or in any manner gain access to the enclosure with interlocked gates or doors closed or with power supply line switches to the equipment closed; or to approach or handle any portion of the equipment which is supplied with power, or to connect any apparatus external to the enclosure to circuits within the equipment; or to apply voltages to the equipment for testing purposes while any non-interlocked portion of the shielding or enclosure is removed or open. Whenever feasible in testing circuits, check for continuity and resistance rather than directly checking voltage at various points.

DON'T SERVICE OR ADJUST ALONE

Under no circumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

DON'T TAMPER WITH INTERLOCKS

Under no circumstances should any access gate, door or safety interlock switch be removed, short circuited, or tampered with in any way, nor should reliance be placed upon the interlock switches for removing voltages from the equipment.

THE ATTENTION OF OFFICERS AND OPERATING PERSONNEL IS DIRECTED TO BUREAU OF SHIPS MANUAL OF ENGINEERING INSTRUCTIONS, CHAPTER 31 (MIMEOGRAPHED FORM) OR SUBSEQUENT REVISIONS THEREOF ON THE SUBJECT OF 'RADIO — SAFETY PRECAUTIONS TO BE OBSERVED.'

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Note: Fig. 128 and Fig. 129 are enclosed in an envelope next to the rear cover of this Instruction Book.

GUARANTEE: 2 YEARS', 1 YEAR SERVICE

The equipment, including all parts and spare parts, except vacuum tubes, shall be guaranteed for a service period of one year with the understanding that, as a condition of this contract, all items found to be defective as to design, material, workmanship, or manufacture shall be replaced without delay and at no expense to the Government, provided that such guarantee and agreement shall not obligate the contractor to make replacement of defective material unless the failure, exclusive of normal shelf life deterioration, occurs within a period of two years from the date of delivery of the equipment to and acceptance by the Government, and provided further, that if any part or parts (except vacuum tubes) fail in service or are found defective in ten per cent (10%) or more, but not less than two, of the total number of equipments furnished under the contract, such part or parts, whether supplied in the equipment or as spares, shall be conclusively presumed to be of defective design, and as a condition of contract subject to one-hundred per cent (100%) replacement of all similar units supplied on subject contract by suitable redesigned replacements. Failure due to poor workmanship while not necessarily indicating poor design, will be considered in the same category as failure due to poor design. Redesigned replacements which will assure proper operation of the equipment shall be supplied promptly, transportation paid, to the Naval activities using such equipment, upon receipt of proper notice and without cost to the Government. All defective parts originally furnished under contract shall be held subject to rejection and return to the contractor.

This period of two years and the service period of one year shall not include any portion of the time that the equipment fails to give satisfactory performance due to defective items and the necessity for replacement thereof, and provided further, that any replacement part shall be guaranteed to give one year of satisfactory service.

REPORT OF FAILURE

Report of failure of any part of this equipment, during its service life, shall be made to the Bureau of Ships in accordance with current instructions. The report shall cover all details of the failure and give the date of installation of the equipment. For procedure in reporting failures see Chapter 31 (mimeographed form) of the Manual of Engineering Instructions, or Bureau of Ships Radio and Sound Bulletin Number 7, dated July 1, 1942, or superseding instructions.

Contract: NXss-5515 Contract Dated 16 November 1942

Serial Number of Equipment____

Date of Acceptance by the Navy____________________________________

Date of Delivery to Contract Destination____________________________

Date of Completion of Installation_________________________________

Date Placed in Service____

Blank spaces in this book shall be filled in at time of installation. Operating personnel shall also mark the "date placed in service" on the date plate located below the model nameplate on the equipment, using suitable methods and care to avoid damaging the equipment.

All requests or requisitions for replacement material should include complete descriptive data covering the part desired, in the following form:

1. Name of part desired.
2. Navy Type number (if assigned) (including prefix and suffix as applicable).
3. Model designation (including suffix) of equipment in which used.
4. Navy Type designation (including prefix and suffix where applicable) of major unit in which part is used.
5. Symbol designation of part.
6. (a) Navy Drawing Number.
   (b) Manufacturer's Drawing Number.
7. Rating or other descriptive data.
8. Commercial designation.

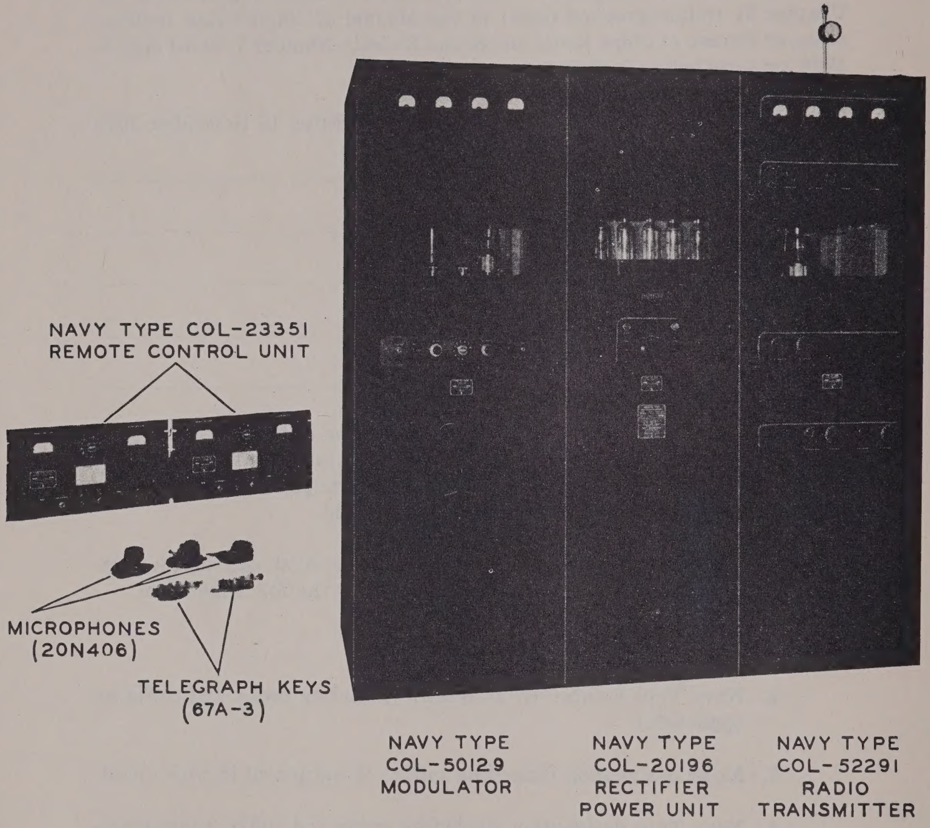


Fig. 1 Complete Radio Transmitting Equipment
(Photo No. 8704)

I GENERAL DESCRIPTION

1.1. **EQUIPMENT.** This Instruction Book covers the installation, adjustment, operation and maintenance of the Navy Type TDH Radio Transmitting equipment. The complete equipment consists of the following units and accessories:

Navy Type No.	Collins Part No.	Qty.	Description	Overall Dimensions	Weight Gross	Weight Net
COL-20196	1100C-1	1	Rectifier Power Unit	25″ x 31″x84″	1830 #	1350 #
COL-50129	1025-4	1	Modulator	28½″x31″x84″	1390 #	830 #
COL-52291	1016-5	1	Radio Transmitter	28½″ x 31″ x 95⅝″	1730 #	775 #
COL-23351	177G-7	2	Remote Control Unit	8-15/16″ x 10½″ x 19″	140 #	60 #
	426N6	1	Power Cord			
-51004	20N406	3	Microphone	4′ (cord)		
	67A-3	2	Telegraph Key & Cord	3′ (cord)		
	GA-2649A	1	Meter Extension Cord	10′		
	178B-2	1	Antenna Ammeter	11⅝″		
	GA-1198C	1	Test Cable (Red)	10′		
	GB-1198C	1	Test Cable (Green)	10′		
	146A	1	CFI Unit Crystal			
		1	Kit Assembly Hardware			
			Spare Tubes (2 Sets)		62 #	36 #
			Spare Parts		230 #	187 #

When packed for shipment, the total gross weight of the complete equipment is 5716 lbs. The net weight of the complete equipment is 3325 lbs.

Note: In addition to the equipment listed above, it will be necessary to obtain a pair of headphones to use in conjunction with the oscillator calibration unit. The circuit is designed to operate satisfactorily with headphones of from 500 ohms impedance up to and including high impedance phones such as the crystal type.

1.2. **GENERAL DESCRIPTION.** This equipment has been designed for applications involving point-to-point communication, aeronautical ground stations and other services requiring operation on a number of readily selected frequency channels. The transmitter is equipped with the Collins Autotune System which permits the selection of any one of eleven pre-tuned frequency channels by the operation of a telephone dial on the transmitter control panel or a dial located on the remote control unit.

1.2.1. **Transmitter.** The transmitter is contained in three bays or cabinets and requires a space 31″ deep by 82 1/16″ wide by 95⅝″ high and enough additional space to permit the free circulation of air and to permit the making of antenna and ground connections. The cabinets are finished with a zinc chromate primer and a final coat of black crinkle on the outside and are painted flat gray on the inside. The Navy Type COL-52291 Radio Transmitter cabinet contains all r-f units and the Autotune control system. The Navy Type COL-20196 Rectifier Power Unit cabinet contains the bias, low voltage and high voltage power supplies and all transmitter power controls. The Navy Type COL-50129 Modulator cabinet contains the speech amplifier, audio driver and modulator circuit components. Each of the cabinets is equipped with full length front and rear doors. All three cabinets are equipped with door interlock switches so that power is immediately removed when either a front or rear door is opened. Glass windows in the front door of the r-f and audio bays permit the viewing of all indicating instruments without opening the cabinet doors. All Autotune control knobs are accessible through openings in the cabinet front doors so that tuning adjustments may be made without opening the doors.

All three bays are ventilated by a blower located in the base of the Navy Type COL-50129 Modulator cabinet. The air is forced into the power and r-f bays through ducts located in the bases of the cabinet. The air is exhausted in such a manner that dust is not permitted to settle on the transmitter components.

The following paragraphs give a brief description of the various units comprising the transmitter:

(a) **Output Network.** This unit contains the components of the pi network that is used as a combination power amplifier plate tank and antenna coupling circuit. The two variable capacitors and the tap switch are driven by heavy duty singleturn units that are associated with the Autotune system.

(b) **Power Amplifier Unit.** The power amplifier tubes, the intermediate amplifier plate tank circuit and a stabilizer circuit are contained in this unit. The network contained in this unit is a combination intermediate amplifier plate tank and power amplifier grid circuit. The tank circuit utilizes a pair of tapped inductors and two variable capacitors to make up a balanced tank circuit. The variable capacitor and inductor tap switch are driven by singleturn units. The stabilizing circuit utilizes a Type 811 triode as an electronic load on the grid circuit of the power amplifier tubes.

(c) **R-F Exciter Unit.** The remaining r-f circuit components are contained in this unit. Two singleturn units and one multiturn unit associated with the Autotune system drive the variable components within the unit. The two singleturn units drive the two variable capacitors located in the plate tank circuits of the R-F Multiplier and R-F Amplifier-Tripler and the band switch that connects the proper inductor in these plate circuits. The multiturn unit drives the tuning slug within the master oscillator tank inductor to vary the frequency of the r-f output. The master oscillator components are packed in an insulating material and sealed in a compartment that is kept at a constant temperature by a thermostatically controlled heater. The components within this unit have been carefully placed and shielded to obtain the best possible performance. The Crystal Frequency Indicator (CFI) Unit mounts on the top of the exciter chassis. Filament voltages for the tubes within the R-F Exciter and CFI Units are supplied by two transformers that are mounted on the R-F Exciter Unit chassis. All connections to this unit except those that are made to the intermediate amplifier plate caps are made by plug-in connectors on the rear of the chassis. The circuit seeking switch and the limit switch that control the Autotune system are located in the R-F Exciter Unit.

(d) **Autotune Control Unit.** All of the Autotune system control relays are mounted in this unit. All of these relays are of the 48 volt d-c type and are supplied with voltage by a dry disc rectifier that is mounted on the power chassis. All connections to this unit are made by two plug-in connectors that are located on the rear of the chassis.

(e) **Power Unit.** All of the power supplies and all of the power controls are mounted on the vertical chassis that makes up the power unit. Four rectifier supplies furnish all voltages for operation of both r-f and audio circuits within the transmitter. The relay supply utilizes a dry disc rectifier to obtain the 48 volts d.c. Two autotransformers are located near the bottom of the vertical chassis.

The terminals of the transformers are brought out through the front of the chassis so that adjustments may be made to compensate for low or high power source voltage. A panel, mounted near the center of the unit, contains all of the power controls. The high voltage plate transformer mounts behind the vertical chassis.

(f) **Modulator and Audio Driver Unit.** This unit contains the components of the cathode coupled audio driver and modulator stages and the hand set coupling transformer. The components in this unit are mounted on a chassis that is bolted into the modulator cabinet. All connections are made by means of cables. The transformer that supplies the voltage for the filaments of the audio driver tubes is mounted in this unit but the transformer that supplies voltage for the modulator tubes is mounted on a separate chassis.

(g) **Speech Amplifier Unit.** This unit contains the first, second, and third audio amplifier stages, the audio limiter and audio squelch circuits and the MCW oscillator circuit. Four controls on the front of the chassis control the MCW frequency, MCW gain, audio gain and limiter gain. The local-remote switch, the test switch, the telephone dial, the key jack and microphone jack are also mounted on this unit. Connections to the unit are made by two plugs that are mounted on the rear of the chassis. Filament voltages for all tubes in this unit are supplied by a transformer that is mounted on a chassis with the modulator filament transformer.

(h) **Base Components.** The PHONE-CW relay, the intermediate voltage filter capacitor and the high voltage filter capacitor are mounted in the base of the Navy Type COL-52291 Radio Transmitter cabinet. The modulation transformer and the ventilating blower are mounted in the base of the Navy Type COL-50129 Modulator cabinet.

1.2.2. Remote Control Unit. The panels of the Remote Control Units are finished in flat black and the chassis is finished in flat gray. This unit may be located at any distance from the transmitter up to the distance for which the line loss becomes greater than 25 db or the resistance of the line loop becomes greater than 1000 ohms. This unit may be used to control all functions of the transmitter. The power supply for the tubes is contained within the unit and is designed for operation from a 115 volt 50/60 cps single phase power source.

1.2.3. Tube Complement. One complete set of vacuum tubes for the Transmitting Equipment consists of:

NAVY TYPE COL-52291 RADIO TRANSMITTER

Symbol Designation	Navy Type Number	Circuit Function	Unit
V101	6A8	Master Oscillator	R-F Exciter
V102	6AG7	R-F Amplifier	R-F Exciter
V103	807	R-F Multiplier	R-F Exciter
V104	807	R-F Amplifier-Tripler	R-F Exciter
V105	813	Intermediate Amplifier	R-F Exciter
V106	813	Intermediate Amplifier	R-F Exciter
V107	VR150-30	Voltage Regulator	R-F Exciter
V109	6SJ7	Keyer	R-F Exciter
V110	6SL7GT	CFI Converter	CFI
V111	6A8	CFI Oscillator	CFI
V113	6SN7GT	CFI Audio Amplifier	CFI
V114	750TL	Power Amplifier	Power Amp.
V115	750TL	Power Amplifier	Power Amp.
V116	811	P. A. Stabilizer	Power Amp.

NAVY TYPE COL-20196 RECTIFIER POWER UNIT

Symbol Designation	Navy Type Number	Circuit Function	Unit
V201	872A	High Voltage Rectifier	Power
V202	872A	High Voltage Rectifier	Power
V203	872A	High Voltage Rectifier	Power
V204	872A	High Voltage Rectifier	Power
V205	872A	High Voltage Rectifier	Power
V206	872A	High Voltage Rectifier	Power
V207	866/866A	Low Voltage Rectifier	Power
V208	866/866A	Low Voltage Rectifier	Power
V209	866/866A	Bias Rectifier	Power
V210	866/866A	Bias Rectifier	Power

NAVY TYPE COL-50129 MODULATOR

V301	6SL7GT	Audio Amplifier	Speech Amp.
V302	6C8G	Limiter	Speech Amp.
V303	6C8G	Audio Squelch	Speech Amp.
V304	6SJ7	Audio Amplifier	Speech Amp.
V305	6SN7GT	MCW Oscillator	Speech Amp.
V306	6X5GT	Limiter Rectifier	Speech Amp.
V307	801	Audio Amplifier	Speech Amp.
V308	801	Audio Amplifier	Speech Amp.
V309	845	Audio Driver	Mod. & Driver
V310	845	Audio Driver	Mod. & Driver
V311	450TL	Modulator	Mod. & Driver
V312	450TL	Modulator	Mod. & Driver

1.3. POWER SOURCE. The transmitting equipment proper is designed to operate from a 230 volt 50/60 cps 3 phase power source. The equipment draws a maximum of 30 amperes when operating with full 3 kw output. The power required under varying operating conditions is tabulated below:

Condition	Power Input
CW—Standby	1840 watts
VOICE & MCW—Standby	3160 watts
CW—Key Closed	6480 watts
MCW—Key Closed	7240 watts
VOICE—100% modulation	9920 watts

The Remote Control Unit is designed to operate from a 115 volt 50/60 cps single phase power source and requires approximately 20 watts for normal operation. The power factor in all cases is approximately 85%.

1.4. POWER OUTPUT. The r-f carrier output measured into a non-inductive resistance load of approximately 300 ohms is not less than 3000 watts in the frequency range 2000 kc to 12,000 kc and not less than 2500 watts in the frequency range 12,000 kc to 18,100 kc. The above applies for all of the three types of emission, CW, MCW, and VOICE.

1.5. TYPE OF EMISSION. CW (A1), MCW (A2), and VOICE (A3) emissions are available with this equipment. Electronic carrier control is used and permits keying speeds of up to two hundred words per minute with A1 emission and keying speeds up to sixty words per minute with A2 emission. The modulation frequency for A2 emission is variable in seven steps in the range 400 cps to 1200 cps.

1.6. FREQUENCY RANGE. The equipment is capable of operation on any frequency within the range 2000 kc to 18,100 kc. The power amplifier output coupling network is designed to work into unbalanced antennas or transmission lines having impedances of from 50 to 1200 ohms with a phase angle of 0°, 70 to 850 ohms with a phase angle of ±45°, and 100 to 600 ohms with a phase angle of ±60°.

1.7. FREQUENCY CHANGE SYSTEM. The equipment employs the Collins Autotune System of frequency selection. The Autotune system provides for quick frequency change by mechanically repositioning the various tuning elements to preset positions. The positioning elements are driven by a single motor which is controlled by a series of interlocking relays. The whole system will operate to change the frequency of transmission within a period of fifteen seconds. Any one of eleven frequency channels or manual tuning may be selected by dialing.

The Autotune mechanisms are constructed with mechanical play and can therefore have two extreme rotational settings when locked. All dials, when operated automatically, approach the calibrated setting in a clockwise direction. Reset accuracy is thus assured, provided that in the preliminary manual tuning, the final direction of rotation is also in a clockwise direction. The details of the cams may be found in Fig. 5 and Fig. 6.

1.8. FREQUENCY CONTROL. The frequency of the r-f output is controlled by a stable master oscillator operating in the frequency range 1000 kc to 1510 kc. Two frequency multiplier stages are employed to obtain output in the 2000 kc to 18,100 kc frequency range.

1.9. AUDIO CHARACTERISTICS. The overall frequency response, as measured between the 500 ohm input and the rectified carrier output, is uniform within 3 db from 150 cps to 3500 cps. The compression circuit has negligible effect with modulation levels below 70% modulation. For modulation levels above 70%, a change of 10 db in input level will cause a change in output level that does not exceed 3 db. The noise on the carrier, with a 500 ohm resistor connected across the audio input circuit, is more than 40 db below 100% modulation level. The harmonic distortion with 100% modulation does not exceed 10% with input at 400 cps.

1.10. PANEL CONTROL. The panel controls on the transmitter consist of a telephone dial for selecting frequency channels and type of emission, a power level switch, a local-remote switch, filament and plate power switches, a test key switch, a telegraph key cord plug receptacle and a microphone cord plug receptacle. The above controls permit the operator to apply or remove power, to select the frequency of transmission, to select the type of emission, and to control the emission from a position adjacent to the transmitter proper.

1.11. REMOTE CONTROL. The remote control unit permits an operator to perform all of the operations that are necessary to select the frequency channel, select the type of emission, control the emission and to turn the transmitter on and off from any distance up to the distance where the resistance of the remote line loop becomes greater than 1000 ohms or the loss in the line exceeds 25 db. All of the above functions except the control of the carrier are performed by dialing. The control system requires two cable pairs and a ground return circuit. A receiver disabling circuit has been incorporated in the control unit to disable the receiver when the transmitter carrier is on.

1.12. ABBREVIATIONS. Throughout this Instruction Book abbreviations have been used in place of some of the more common radio terms and phrases. The abbreviations that are used in the sections that follow will not be defined but it will be assumed that reference will be made to the list below:

a-c—alternating current
a-f—audio frequency
amp.—amperes
ant.—antenna
AWG—American Wire Gage

BSG—Browne & Sharpe Gage
CFI—Crystal Frequency Indicator
CT—Center Tapped
CW—Continuous Wave (telegraphy)
d-c—direct current
DPDT—Double Pole, Double Throw (switch)
DPST—Double Pole, Single Throw (switch)
Fil.—filament
Gnd.—ground (earth or chassis)
hy—henry (unit of inductance)
h-v—high voltage
kc—kilocycles
L.—symbol for inductance
LOCAL—Control of the transmitter using panel controls
l-v—low voltage
ma—milliamperes
mc—megacycles
MCW—Modulated Continuous Wave (telegraphy)
mfd—microfarads
mmfd—micromicrofarads
mh—millihenries
MO—Master Oscillator
MOD.—Modulator, Modulation
mw—milliwatts
N.C.—Normally Closed
N.O.—Normally Open
osc.—oscillator
P.A.—Power Amplifier
REMOTE — Control of the transmitter from a remote position
r-f—radio frequency
SPDT—Single Pole, Double Throw (switch or relay)
T.—Turns (inductor)
term.—terminal
TV—Test Voltage
v—volts
VA—Volt-Amperes
Voice—speech modulated transmission (telephony)
w—watts
WV—Working Voltage

2.1. GENERAL. Unit type of construction is employed in this transmitter. Most of the components, except the larger transformers, are mounted on removable chassis or panels. All connections to the r-f exciter, Autotune control, speech amplifier and audio filament supply units are made with heavy duty multi-terminal connector plugs. All connections to the power supply unit are made to terminal strips on the rear of the panel. Below is a tabulation of the units and the arbitrary letter which has been assigned to each unit for use as a reference to indicate inter-unit cabling connections:

Letter Designation	Title
A	R-F Bay Meter Panel
B	Output Network
C	Power Amplifier
D	R-F Exciter
E	Autotune Control
G	P.A. Filament Supply
H	R-F Bay Base Components
J	R-F Bay Terminals
K	Power Chassis
L	Modulator Bay Terminals
M	Modulator Bay Meter Panel
N	Modulator and Driver
P	Speech Amplifier
R	Filament Supply
S	Mod. Bay Base Components

2.2. POWER CONTROL CIRCUITS. Refer to Fig. 2 . This transmitter has been designed for normal control from a remote position using the Navy Type COL-23351 Remote Control Unit. A key switch located on the speech amplifier unit panel permits the transfer of power and emission control from the remote control unit to the panel controls.

2.2.1. Sequence of Power Application. The sequence of power application is the same whether LOCAL or REMOTE control is employed and is as follows:

(a) **Remote Control.** (Circuit breaker, S211, in ON position.)
1. FILAMENT relay operated by any dialing operation.
2. TIME DELAY relay operates.
3. PLATE CONTROL relay operates.
4. BIAS INTERLOCK relay operates.
5. LO-POWER relay or HI-POWER relay operates.

(b) **Local Control.**
1. Operate CIRCUIT BREAKER to ON position.
2. Pressing FILAMENT START button operates FILAMENT relay.
3. TIME DELAY relay operates.
4. Pressing PLATE START button operates PLATE CONTROL relay.
5. BIAS INTERLOCK relay operates.
6. LO-POWER relay or HI-POWER relay operates.

2.2.2. Remote Control. With the LOCAL-REMOTE switch, S303, in the normal or REMOTE position, the filament relay will be immediately energized by the operation of the circuit breaker, S211, to the ON position. The filament relay will be energized by the circuit through the contacts of the transmitter off relay, K106, and the contacts of the LOCAL-REMOTE switch. The operation of the filament relay energizes the time delay relay, K204, and all filament transformers. When sufficient time has elapsed, the time delay will operate and close the circuit necessary for the energizing of the plate control relay, K206. The plate control relay is of the 48 volt d-c type and is energized by the circuit through the contacts of the LOCAL-REMOTE switch, the contacts of the time delay relay, the contacts of the power amplifier overload relay, and the door interlock switches of all three cabinets and the air flow switch. The air flow switch, S308, is located in the modulator cabinet and is operated by the air stream from the ventilating blower. If the blower fails to operate it is impossible to energize the high voltage supply.

If the ADJUST-OPERATE switch, S210, is operated to the ADJUST position, the door

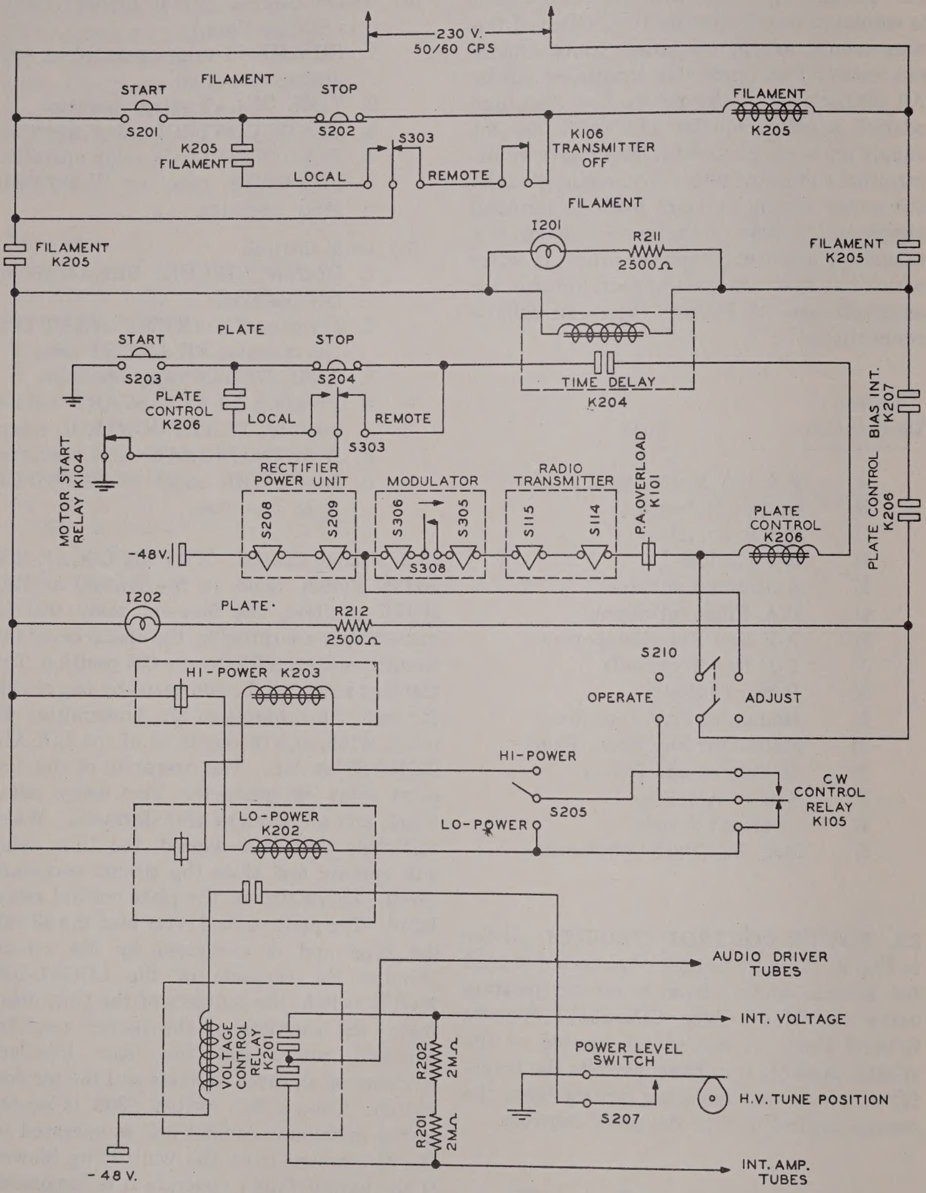


Fig. 2 Power Control Circuits (Dwg. No. 500 0703 00C)

interlock switches in the radio transmitter and modulator cabinets and the air flow interlock switch are shorted out to permit the adjustment of low power circuits within these bays with the cabinet doors open.

With the ADJUST-OPERATE switch in the OPERATE position and the time delay and bias interlock relays operated, either the LO-POWER relay, K202, or the HI-POWER relay, K203, will be energized. (The relay that is energized depends upon the position of the power level switch, S205, and the type of emission that has been selected.) If switch S205 is operated to the LO-POWER position, the LO-POWER relay will be energized by the circuit through the contacts of the filament relay, the contacts of the bias interlock relay, the contacts of the plate control relay, the contacts of the OPERATE-ADJUST switch, the contacts of the CW control relay and the normally closed contacts of the HI-POWER relay.

High power operation is only possible with CW emission. Even with the power level switch in the HIGH position, the circuit necessary for the energizing of the HI-POWER relay is not completed unless CW emission is selected by dialing A1. The change in power level is made by changing the turns-ratio of the plate power transformer, T203.

The operation of the LO-POWER relay breaks the energizing circuit for the HI-POWER relay and the normally open contacts close the circuit to the voltage control relay, K201. If the TUNE-OPERATE switch, S207, is in the H.V. TUNE position (as shown on Fig. 2) the energizing circuit for the voltage control relay will be broken. If the switch is operated to the OPERATE position the voltage control relay will operate following the operation of the LO-POWER relay. The operation of relay K201 applies plate voltage to the audio driver tubes and shorts out resistors R201 and R202 to increase the voltage that is applied to the intermediate amplifier tube plates.

2.2.3. Local Control. If the LOCAL-REMOTE switch on the speech amplifier panel is operated to the LOCAL position, control of power and emission is transferred to the controls located on the speech amplifier unit panel.

To begin the sequence of power application, the FILAMENT START switch, S201, must be pressed. The momentary closing of the circuit through switch S201 actuates the filament relay, K205. The filament relay is held operated by the circuit through the normally closed contacts of the FILAMENT STOP switch, S202, the contacts of the FILAMENT relay, and the normally open (as shown on Fig. 2) contacts of the LOCAL-REMOTE switch.

The operation of the filament relay energizes the time delay relay, K204, and all filament transformers. Following the operation of the time delay relay, the low voltage plate supplies will be energized if the PLATE START switch, S203, is pressed. The operating of switch, S203, energizes the plate control relay, K206. The plate control relay is held operated by the circuit through the contacts of the motor start relay, the contacts of the LOCAL-REMOTE switch, the contacts of the plate control relay, the normally closed contacts of the PLATE STOP switch, the contacts of the time delay relay, the contacts of the power amplifier overload relay, the cabinet door interlock switches and the air flow switch. Operating the ADJUST-OPERATE switch to the ADJUST position shorts-out the interlock switches in the radio transmitter and modulator cabinets.

If the ADJUST-OPERATE switch is in the OPERATE position, the operation of the plate control relay completes the circuit necessary to energize the LO-POWER relay, K202. If CW emission is selected by dialing A1 (operates the CW control relay, K105) and the power level switch is in the HI-POWER position, the HI-POWER relay, K203, will be operated. High power can only be used with CW emission, no matter what position the power level switch is in, because the CW control relay must be operated if the circuit necessary for the energizing of the HI-POWER relay is to be completed. If the TUNE-OPERATE switch, S207, is in the

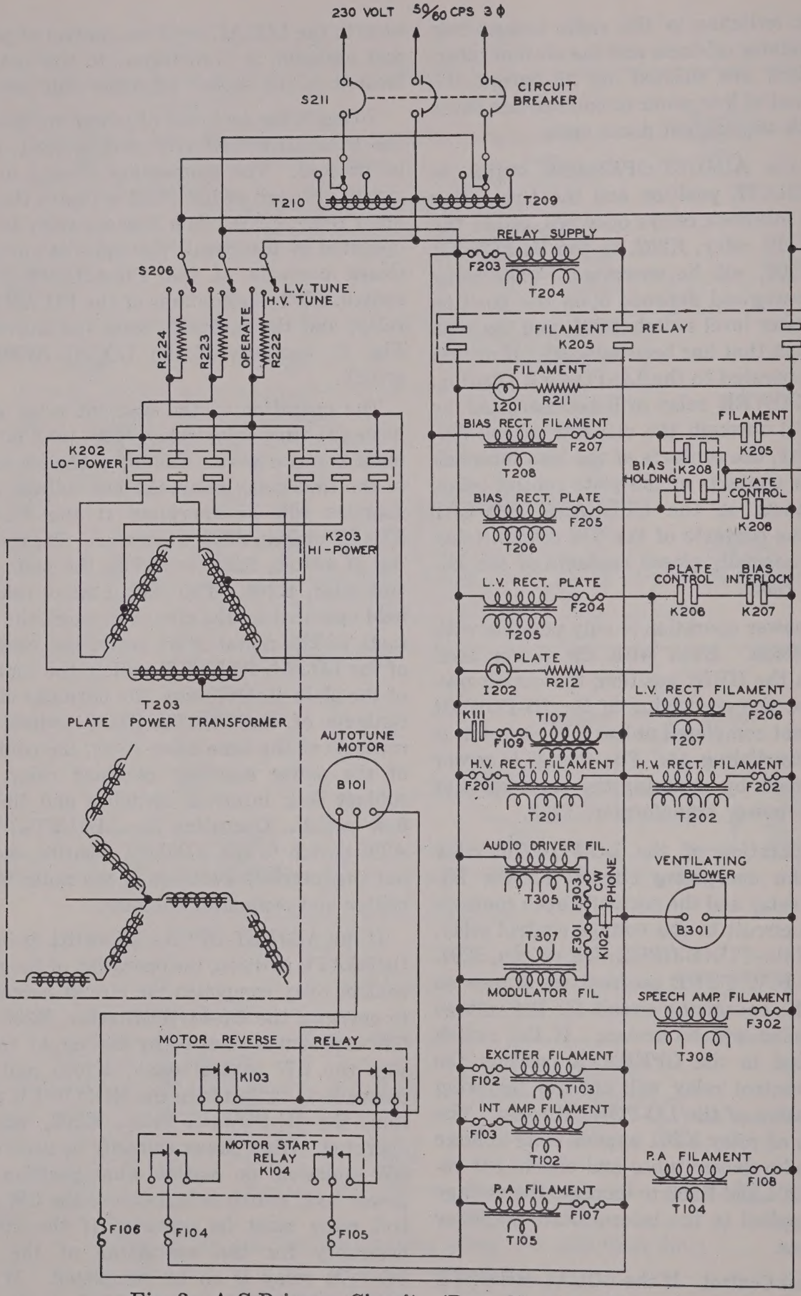


Fig. 3 A-C Primary Circuits (Dwg. No. 500 0738 00C)

OPERATE position (H.V. TUNE position shown in Fig. 2), the operation of the LO-POWER relay will complete the circuit necessary for the energizing of the voltage control relay, K201. The operation of the voltage control relay shorts out resistors R201 and R202 to increase the voltage that is applied to the intermediate amplifier tube plates and applies plate voltage to the audio driver tubes.

Pressing the FILAMENT STOP switch will release all relays and remove all power from the transmitter except that which is applied to the relay rectifier supply.

2.3. A-C PRIMARY CIRCUITS. Refer to Fig. 3. The transmitter has been designed to operate from a 230 volt 50/60 cps 3 phase power source. A circuit breaker, S211, is connected in the primary power line to permit the complete disconnecting of the primary power from the transmitter circuit. Two auto-transformers, T209 and T210, are connected across the three phase line so that adjustments of voltage may be made to compensate for high or low power source voltage. The three phase power is applied to the auto-

from the transmitter except that which is applied to the relay rectifier supply.

Primary power for application to the plate power transformer, T203, is controlled by the TUNE-OPERATE switch, S206, and the LO-POWER and HI-POWER relays, K202 and K203. With the TUNE-OPERATE switch in the L.V. TUNE position the circuit to the primary of the plate power transformer is broken. If the switch is operated to the H.V. TUNE position, tuning resistors, R222, R223, and R224, are connected in series with the 230 volt leads to reduce the voltage that is applied to the tubes during the period when the higher power r-f stages are being adjusted.

Whether the LO-POWER relay or the HI-POWER relay is operated, depends upon the position of the power level switch, S205, and the type of emission that is selected. (The operation of control circuit is described under **2.2. POWER CONTROL CIRCUITS.**) The LO-POWER relay is always operated when transmitting with MCW or VOICE emission, no matter which position of switch S205 is selected. If the switch is operated to the HIGH position and CW emission is selected, the HI-POWER relay will be operated. The operation of the HI-POWER relay increases the turns ratio of the plate power transformer and thus increases the voltage that is applied to the power amplifier tubes.

The relay rectifier and master oscillator compartment heater supply transformer is immediately energized following the operation of the circuit breaker. The remaining transformer and motor primary circuits cannot be energized until the filament relay, K205, has been operated.

As explained under 2.2. **POWER CONTROL CIRCUITS.**, the equipment is designed for normal control from a remote position. With the LOCAL-REMOTE switch in the REMOTE position, the filament relay will immediately be energized by the operation of the circuit breaker.

The operation of the filament relay lights the FILAMENT pilot lamp, I201, energizes the bias filament, low voltage rectifier filament, the two high voltage rectifier filament, the audio driver filament, the modulator filament, the speech amplifier filament, the exciter filament, the intermediate amplifier filament and the power amplifier filament transformers and the ventilating blower.

When the time delay relay, K204, has operated, the plate control relay, K206, will be energized. The operation of the plate control relay energizes the PLATE pilot lamp, I202, and the bias rectifier plate transformer, T206. The application of plate voltage to the bias rectifiers energizes the bias interlock relay which when operated completes the circuit necessary to energize the low voltage rectifier plate transformer, T205, and the circuit necessary to energize either the LO-POWER relay or the HI-POWER relay. (Refer to Fig. 2.) The operation of either of the plate power relays will energize the plate power transformer.

The selection of CW emission by dialing A1 will operate the phone-CW relay to remove the filament voltage from the audio driver and modulator tubes.

The bias holding relay coil is connected in series with the high voltage supply bleeder. Thus the bias supply is kept energized as long as the high voltage supply is operating to prevent the damaging of the higher power tubes by applying plate voltage without having bias on the grids.

The Autotune motor control relays are controlled by the Autotune control circuits.

All transformer primaries except the plate power transformer primary are fused to prevent the damaging of the transformers by sudden overloads. The plate power transformer is protected by the transmitter circuit-breaker.

With the LOCAL-REMOTE switch operated to the LOCAL position, the application of primary power is controlled by the operation of the FILAMENT and PLATE START and STOP switches, located on the power rectifier unit control panel. The functions of all other circuits are the same as described for REMOTE control.

2.4. FILAMENT CIRCUITS. Refer to the Cabling and Complete Transmitter Schematics in the APPENDIX of this book. Filament power for all tubes in the transmitter is supplied by step-down transformers.

Filament voltage for the master oscillator (V101), the r-f amplifier (V102), the r-f multiplier (V103), the r-f amplifier-tripler (V104), the keyer tube (V109), the CFI converter (V110), the CFI oscillator (V111), and the CFI output amplifier (V113) is supplied by transformer T103. All of the above tubes are located in the R-F Exciter Unit. Filament voltage for the intermediate amplifier tubes (V105 and V106) is supplied by transformer T102. The filament voltages for all tubes that are located in the R-F Exciter Unit may be measured by inserting the metering cord plug into plug receptacle J104. Filament voltage for the power amplifier tubes (V114 and V115) is furnished by transformers located in the Power Amplifier Filament Supply Unit. A separate transformer is provided for each tube. The P.A. Overload Relay energizing coil is connected between the center taps of transformers T104 and T105 and ground so that if the cathode current of the power amplifier tubes exceeds a safe value the relay will operate and prevent the damaging of V114 and V115 by removing the plate voltage.

Four step-down transformers, located in the power supply unit, furnish voltages for application to the filaments of the bias, low voltage, and high voltage rectifiers. Transformers T201 and T202 furnish the voltage necessary for application to the filaments of the high voltage rectifier tubes (V201, V202, V203, V204, V205, and V206). The output voltage of transformer T201 may be measured by inserting the metering cord plug into plug receptacle J201. The output voltage of transformer T202 may be measured by inserting the metering cord plug into plug receptacle J202.

Filament voltage for the low voltage rectifier tubes (V207 and V208) is furnished by transformer T207. The output voltage of transformer T207 may be measured by inserting the metering cord plug into plug receptacle J203. Filament voltage for the bias rectifiers (V209 and V210) is furnished by transformers T208. The output voltage of transformer T208 may be metered by inserting the metering cord plug into plug receptacle J204.

The filament voltages for all tubes located in the Speech Amplifier Unit are furnished by transformer T308 that is located in the Filament Supply Unit. Two windings on the secondary of transformer T308 furnish 6.3 volts for the first audio amplifier (V301), the limiter (V302), the audio squelch (V303), the second audio amplifier (V304), the MCW oscillator (V305) and the limiter rectifier (V306) tubes and 7.5 volts for application to the filaments of the audio power amplifier stage. The 6.3 volt winding may be metered by inserting the metering cord plug into plug receptacle J311 in the Speech Amplifier Unit. No provision has been made for the metering of the 7.5 volt winding. The two filament voltage windings are on the same transformer and therefore adjusting the output of the 6.3 volt winding to the correct value will regulate the output voltage of the other winding.

Filament voltage for the audio driver tubes (V309 and V310) is furnished by transformer T305 located in the Modulator and Driver Unit. Because the cathode follower type of audio driver is used separate windings on the secondary of transformer T305 furnish the voltages for V309 and V310. The secondary voltage of the transformer may be measured by inserting the metering cord plug into plug receptacle J305. Filament voltage for application to the filaments of the modulator tubes (V311 and V312) is furnished by transformer T307 in the Filament Supply Unit. The output voltage of transformer T307 may be measured by inserting the metering cord plug into plug receptacle J304 in the Modulator and Driver Unit. Filament voltage for application to the amplifier tubes in the Remote Control Unit is furnished by power transformer T403. No provision has been made for the metering of the filament winding of this transformer.

All filament transformers have tapped primary windings so that the secondary voltages may be adjusted to compensate for low or high supply voltage. The primary windings of all of the transformers are fused.

2.5. HIGH VOLTAGE AND RELAY SUPPLY CIRCUITS. Refer to the Cabling and Complete Transmitter Schematics in the APPENDIX of this book. Three vacuum tube rectifier systems and a dry disc rectifier supply d-c power for the operation of all vacuum tubes and the d-c relays within the transmitter. All four rectifier systems are located in the Navy Type COL-20196 Rectifier Power Unit.

The power that is necessary for application to the plates of the vacuum tubes that are located in the Navy Type COL-23351 Remote Control Unit is supplied by a rectifier system that is contained within the control unit.

2.5.1. Bias Supply. The bias supply employs two Type 866/866A half-wave mercury vapor rectifier tubes (V209 and V210). The two half-wave rectifiers are connected in a full-wave single phase rectifier circuit. A two-section choke input filter is connected across the output of the rectifier system. The positive side of the rectifier system is at ground potential. A tapped bleeder furnishes the fixed bias voltages necessary for application to the grids of the power amplifier tubes, the grids of the modulator tubes, the grid of the r-f multiplier, the grid of the r-f multiplier-tripler, the grids of the intermediate amplifiers, the grids of the audio power amplifiers and the cathodes of the audio driver tubes. A variable resistor, R217, permits the adjusting of the voltage that is applied to the cathodes of the audio squelch and keyer tubes. Another variable resistor, R203, makes possible the adjusting of the bias voltage that is applied to the grids of the modulator tubes. The bias rectifier filament voltage is applied by the operation of the filament contactor and plate voltage by the operation of the plate control relay. The coil of the bias interlock relay, K207, is connected in series with the bleeder and will operate following the operation of the time delay and plate control relays. The contacts of the no-bias relay, K207, are connected in the primary circuit of the low voltage plate supply and prevent the application of plate voltages to the plates of the tubes until the bias voltage is applied to the grids. As a further precautionary measure a bias holding relay, K208, has been connected in the bias supply primary circuit to keep the bias supply on during the time that the high voltage supply is energized. The coil of relay K208 is connected in series with the high voltage supply bleeder. Thus the bias voltage is kept on the tubes until the high voltage has decayed to a low value.

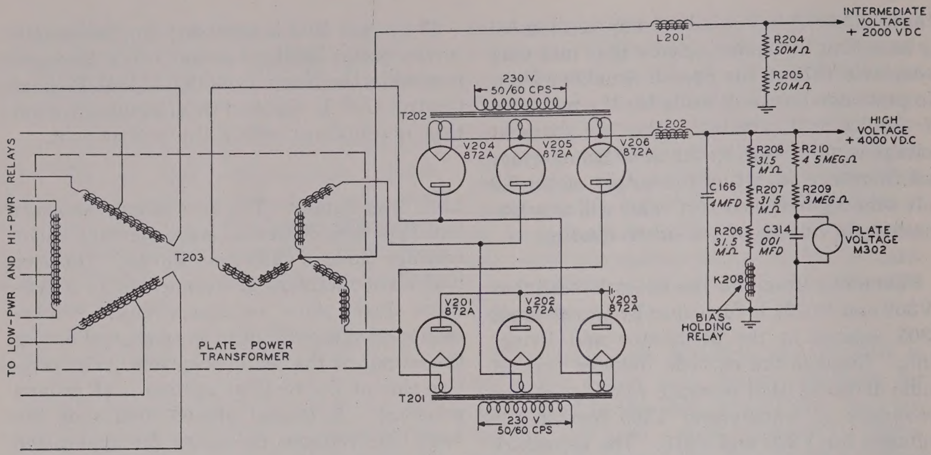


Fig. 4 High Voltage Rectifier Circuit (Dwg. No. 502 0183 002)

2.5.2. Low Voltage Supply. The low voltage power supply employs two Type 866/866A half-wave mercury vapor rectifier tubes (V207 and V208) in a full-wave single phase rectifier circuit. The operation of the filament relay applies filament voltage to V207 and V208. Plate voltage cannot be applied to the rectifiers until the filament relay and the no-bias relay have operated. When the filament contactor and no-bias relay have operated, plate voltage will be applied to V207 and V208 upon the operation of the plate control relay. The negative side of the supply is at ground potential.

The output of the rectifiers is filtered by a two section choke input filter. Bleeder resistors R213 and R225 are connected across the output of the supply. The voltage that is developed across resistor R225 is applied to the microphone when using LOCAL transmitter control. The low voltage supply furnishes plate and screen voltages for the r-f exciter and audio tubes.

2.5.3. High Voltage Supply. The high voltage power supply employs six Type 872A half-wave mercury vapor rectifier tubes (V201, V202, V203, V204, V205, and V206) in a three-phase full-wave rectifier circuit. The plate power transformer, T203, has a Delta connected primary and a Y connected secondary. The full output voltage of the supply is applied to the plates of the r-f power amplifier tubes and the modulator tubes. By tapping the center point of the secondary, one-half of the full voltage of the supply is obtained for application to the plates of the intermediate amplifier tubes. This type of rectifier gives output with a low percentage of ripple. Each voltage is filtered by a single section choke input filter. The negative side of the rectifier system is at ground potential. The full output voltage of the supply is indicated by meter M302, located in the modulator bay. When the power level switch, S205, is operated to the LOW position the full primary winding of the plate power transformer is used. If switch S205 is operated to the HIGH position the turns-ratio of the plate power transformer is increased by tapping the transformer primary so that the 230 volts is impressed on only a section of the primary winding.

During the time that tuning adjustments are being made with the TUNE-OPERATE switch in the H.V. TUNE position, resistors are connected in series with the leads to the transformer primary and in series with the intermediate voltage lead. Refer to Fig. 3.

2.5.4. Relay Power Supply. A selenium rectifier (CR201) supplies the 48 volts d.c. that is necessary for the operation of all d-c relays in the transmitter. Transformer T204 supplies the a-c voltage for application to CR201. The transformer is energized whenever the power switch, S211, is operated to the ON position. Transformer T204 also provides voltage for application to the master oscillator compartment heater resistors, R102 and R103. The primary of the transformer and the output of the rectifier are fused.

2.6. AUTOTUNE SYSTEM.

The Collins Autotune system is an electrically controlled means of mechanically repositioning adjustable elements such as tap switches, variable inductors, variable capacitors and variable resistors. Any combination of these items such as used in radio transmitters and receivers can be tuned to any one of a number of preselected frequencies in a period of less than fifteen seconds by use of the Autotune system.

The Autotune consists of a group of positioning mechanisms, one connected to each tuning element. Each mechanism is provided with a tuning knob so that the elements may be adjusted manually. Each positioning mechanism provides precise angular setting of the tuning element with which it is associated. The position of the tuning element with respect to the mechanism is readily adjustable. The setting for each control is entirely independent of the other controls. Locking bars, located on each tuning dial, lock the tuning element to the mechanism for each predetermined setting of the control.

The accuracy of positioning of the Autotune system is of a very high order. Each setting is inherently independent of wear, backlash, alignment, line voltage, etc. The accuracy of the resetting of the tuning elements is comparable to that obtainable with vernier manual controls. All parts are machined within close limits and although operation is most precise there are no delicate adjustments or fragile mechanisms.

The Autotune system employed in this equipment utilizes seven singleturn units and one multiturn unit to perform the tuning operations necessary for frequency selection, exciter tuning, power amplifier tuning and antenna loading. The multiturn unit operates a tuning slug within the master oscillator grid inductor, L104, to vary the frequency of the output of the oscillator within the frequency range 1000 kc to 1510 kc. Ten revolutions of the multiturn dial are necessary to cover this frequency range. The dial is divided into 100 divisions to permit the accurate positioning of the slug within the inductor. A counter dial divided into 10 divisions shows the number of full revolutions that the dial makes and the dial reading for any particular frequency within the band is obtained by reading the number of full revolutions on the counter dial and the fraction of the revolution on the large tuning dial. Two singleturn units are located on the R-F Exciter Unit, one operating the exciter band switch and the other tuning the frequency multiplier and radio frequency amplifier-tripler plate tank circuits. A channel indicator, located on the same Autotune assembly, is driven by the line shaft that drives the two singleturn units and the multiturn unit. The dial of the channel indicator is divided into 12 divisions engraved with numbers from 1 through 11 and the twelfth position is engraved with the letter M. The numbers indicate the frequency channel to which the Autotune system is operated. When the letter M is opposite the indicator mark, the Autotune system has been operated to the Manual position and all tuning dials may be operated manually without unlocking the stop rings or disturbing the positions of the rings. Thus by selecting manual control, tuning adjustments may be made without danger of disturbing the predetermined settings of the stop rings.

Two singleturn units are mounted on the Power Amplifier Unit and operate the power amplifier grid network switches, S112 and S116, and the grid tuning capacitor, C105.

Three heavy duty singleturn units mounted on the Output Network operate the power amplifier plate tuning capacitor, C158, the power amplifier band switch, S111, and the antenna loading capacitor, C159.

The singleturn units are driven by line shafts and the line shafts are in turn coupled to the drive shaft by gears that are mounted near the lefthand end of the Autotune assemblies. When aligning the Autotune system it is of utmost importance that the coupling shaft between the Autotune assemblies in the R-F Exciter, Power Amplifier, and Output Network Units be in the proper position with respect to each other so that the units in the three assemblies are properly synchronized. The Autotune line shafts are driven by a motor that is mounted on the side of the transmitter cabinet. The motor shaft is coupled to the Autotune drive shaft by a short coupler that incorporates a universal joint to compensate for any misalignment of the drive shafts. The shafts between the Autotune motor and the assembly in the R-F Exciter Unit may be coupled without regard to the positions of the shafts. The complete procedure for synchronizing the units is included in the MAINTENANCE Section of this Instrution Book.

2.6.1. Mechanical Details. The Autotune system in this equipment consists of three assemblies driven by a motor through a series of line and drive shafts. Refer to the drawings of the Collins Autotune System — Mechanical Details. One drawing shows the details of the Light-Duty Autotune and the other drawing shows the details of the Heavy-Duty Autotune. The number that appears before the part or assembly description corresponds to the item number on the drawing.

(a) **Standard Autotune Units.**

1. AUTOTUNE MOTOR. The Autotune motor is a three phase motor and drives the line shafts through a shaft and gear arrangement.

2. DRIVE SHAFT. The drive shaft couples the Autotune motor (1) to the Autotune assemblies. One section of shaft couples the motor to the assembly that is located in the R-F Exciter Unit, and the second section of shaft couples the line shafts of the assemblies on the Power Amp. and Network Units.

3. LINE SHAFT DRIVE GEARS. Each Autotune assembly is provided with a gear box on the left-hand end of the assembly to couple the drive shaft (2) to the line shaft (4).

4. LINE SHAFT. The line shaft extends the entire length of the Autotune casting and drives all Autotune units within the casting. The line shaft is driven by the motor (1) through the gears (3) and the drive shaft (2).

5. SINGLETURN WORM. The singleturn worm drives the singleturn unit and is fastened to the line shaft (4) with a groov-pin.

6. SLIP CLUTCH WORM GEAR. This gear is fastened to the cam drum drive spur gear (7) and drives the stop-ring drum (12) through the slip clutch (11). The gear is driven by the singleturn worm (5).

7. CAM DRUM DRIVE SPUR GEAR. This gear is fastened directly to the slip clutch worm gear (6) and drives the cam drum spur gear (9) through the idler gear (8).

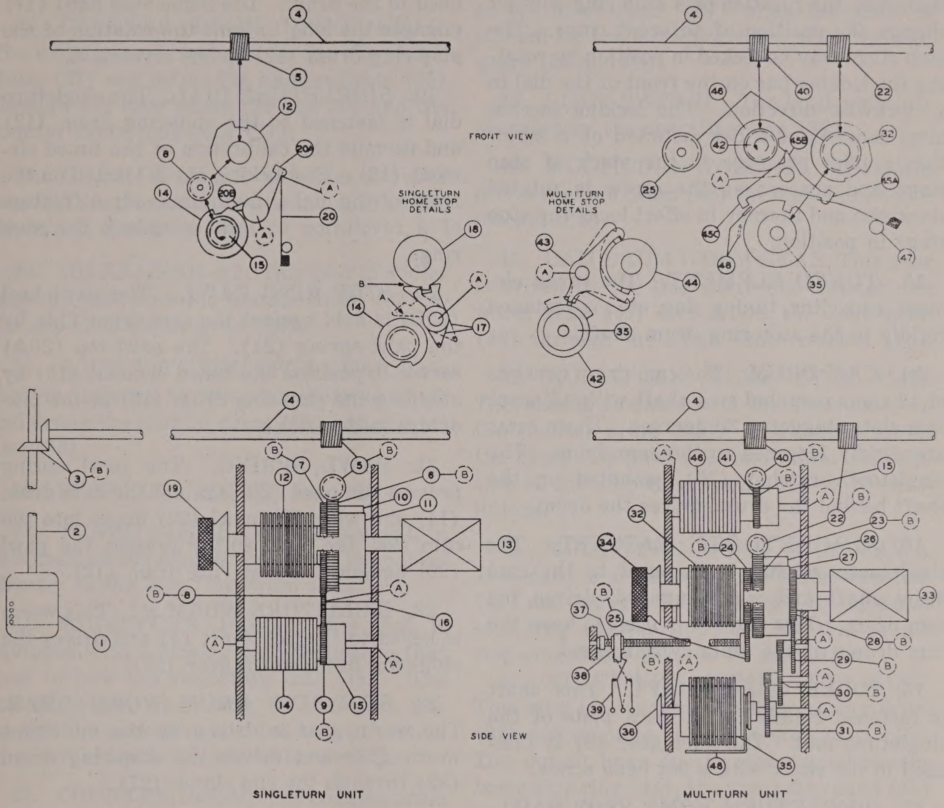
8. IDLER GEAR. This idler gear transmits power from the cam drum drive spur gear (7) to the cam drum spur gear (9).

9. CAM DRUM SPUR GEAR. The cam drum spur gear is driven by the line shaft through the singleturn worm (5), the cam drum drive spur gear (7) and the idler gear (8). The spur gear drives the cam drum (14) through the single tooth ratchet (15).

10. SLIP CLUTCH BAND. The band is driven directly from the slip clutch worm gear (6) and presses against the slip clutch drum (11).

11. SLIP CLUTCH DRUM. The clutch drum is fastened to the stop-ring drum shaft and is driven by the slip clutch band (10).

12. STOP-RING DRUM. The stop-ring drum assembly consists of 12 stop rings mounted on a shaft with spacers between the



LUBRICATING INFORMATION

NOTE: SEE MAINTENANCE SECTION OF INSTRUCTION BOOK FOR DIRECTIONS FOR LUBRICATION

SYMBOL	RECOMMENDED LUBRICANT
(A)	VACTRA OIL-EXTRA HEAVY X
(B)	SOCONY VACUUM VISCOLITE LUBRICANT #10

KEY TO SYMBOLS

1 AUTOTUNE MOTOR
2 DRIVE SHAFT
3 LINE SHAFT DRIVE GEARS
4 LINE SHAFT
5 SINGLETURN WORM
6 SLIP CLUTCH WORM GEAR
7 CAM DRUM DRIVE SPUR GEAR
8 IDLER GEAR
9 CAM DRUM SPUR GEAR
10 SLIP CLUTCH BAND
11 SLIP CLUTCH DRUM
12 STOP RING DRUM
13 TUNED ELEMENT
14 CAM DRUM
15 SINGLE TOOTH RACHET
16 IDLER GEAR SHAFT
17 SINGLETURN HOME STOP PAWL
18 SINGLETURN HOME STOP RING
19 SINGLETURN DIAL
20 PAWL (20A-TOE) (20B-HEEL)
21 PAWL SPRING
22 MULTITURN WORM #1
23 STOP RING DRUM WORM GEAR
24 STOP RING DRUM SPUR GEAR
25 LIMIT SWITCH DRIVE SHAFT SPUR GEAR
26 SLIP CLUTCH BAND
27 SLIP CLUTCH DRUM
28 COUNTER DRUM DRIVE GEAR
29 IDLER GEAR #1
30 IDLER GEAR #2
31 COUNTER DRUM SPUR GEAR
32 STOP RING DRUM
33 TUNED ELEMENT
34 MULTITURN DIAL
35 COUNTER DRUM
36 TURN COUNTER DIAL
37 LIMIT SWITCH DRIVE SHAFT
38 SWITCH OPERATING ARM
39 LIMIT SWITCH
40 MULTITURN WORM #2
41 CAM DRUM WORM GEAR
42 MULTITURN HOME STOP CAM
43 MULTITURN HOME STOP PAWL
44 MULTITURN HOME STOP RING
45 PAWL (45A-TOE)(45B-HEEL) (45C-TAIL)
46 CAM DRUM
47 PAWL SPRING
48 PAWL ANVIL

Fig. 5 Collins Autotune System—Mechanical Details (Dwg. No. K865D)

rings. The stop rings are free to rotate but the spacers are keyed to the shaft in a manner such that the rotation of a stop ring will not change the position of adjacent rings. The stop rings may be locked in position by rotating the locking bar on the front of the dial in a clockwise direction. The locking mechanism consists of a bar mounted on a screw that applies pressure to the stack of stop rings and spacers as the screw is rotated clockwise and thereby in effect locks the stop rings in position.

13. TUNED ELEMENT. The tuned element, capacitor, tuning slug, etc., is fastened rigidly to the stop-ring drum shaft.

14. CAM DRUM. The cam drum consists of 12 cams mounted on a shaft with adjacent cam slots staggered 30 degrees. These cams are rigidly fastened to the cam drum. The singletooth ratchet (15), mounted on the shaft behind the drum, drives the drum.

15. SINGLETOOTH RATCHET. The singletooth ratchet is fastened to the cam drum shaft and when engaged, drives the cam drum. This ratchet is used to keep the cam drums of the units synchronized.

16. IDLER GEAR SHAFT. This shaft is fastened rigidly to the back plate of the singleturn unit. The idler gear (8) is fastened to the shaft with a flat head screw.

17. SINGLETURN HOME STOP PAWL. The singleturn home stop pawl limits the rotation of the singleturn unit to one revolution. The pawl is located on the same shaft as the stop ring pawl (20) and is engaged by the singleturn home stop ring (18). The pawl, shown in solid lines on the drawing, limits the rotation of the stop-ring drum (12) in the counterclockwise direction. The pawl cannot pivot further because of bearing on the stop-ring drum (12) at point B. The pawl shown in dotted lines, limits the rotation of the stop-ring drum (12) in a clockwise direction. The pawl cannot pivot further in this position because of bearing on the cam drum (14) at point A.

18. SINGLETURN HOME STOP RING. This ring, mounted with the other stop rings on the stop-ring drum (12), is rigidly fastened to the drum. The home stop pawl (17) engages the ring to limit the rotation of the stop-ring drum (12) to one revolution.

19. SINGLETURN DIAL. The singleturn dial is fastened to the stop-ring drum (12) and permits the calibration of the tuned element (13). The locking bar is located on the front of the dial and requires only a fraction of a revolution to lock or unlock the stop rings.

20. STOP RING PAWL. The pawl heel (20B) is held against the cam drum (14) by the pawl spring (21). The pawl toe (20A) serves to position the tuned element (13) by stopping the stop-ring drum (12) at the predetermined position.

21. PAWL SPRING. The pawl spring presses the pawl (20) against the cam drum (14) and when the pawl (20) drops into the cam slot, the pawl spring presses the pawl (20) against the stop ring drum (12).

22. MULTITURN WORM #1. This worm is keyed to the line shaft (4) and drives the stop-ring drum worm gear (23).

23. STOP-RING DRUM WORM GEAR. The worm gear is driven by the multiturn worm (22) and drives the stop-ring drum (32) through the slip clutch (27).

24. STOP-RING DRUM SPUR GEAR. This spur gear is fastened to the stop-ring drum and drives the limit switch drive shaft (37) through the drive shaft spur gear (25).

25. LIMIT SWITCH DRIVE SHAFT SPUR GEAR. The gear is driven by the stop-ring drum spur gear (24) and drives the limit switch drive shaft (37).

26. SLIP CLUTCH BAND. The slip clutch band is driven by the worm gear (23) and drives the stop-ring drum (32) through the slip clutch drum (27).

27. SLIP CLUTCH DRUM. This clutch, similar to the slip clutch drum (11) on the singleturn unit, is driven by the slip clutch

band (26) and is fastened to the stop-ring drum shaft.

28. COUNTER DRUM DRIVE GEAR. The drive gear is fastened to the slip clutch drum (27) and drives the counter drum (35) through the idler gears (29 and 30) and the counter drum spur gear (31).

29. IDLER GEAR #1. This gear and idler gear #2 couple the counter drum (35) to the slip clutch spur gear (28).

30. IDLER GEAR #2. This gear and idler gear #1 (29) link the counter drum (35) to the slip clutch spur gear (28).

31. COUNTER DRUM SPUR GEAR. This gear is fastened to the counter drum shaft and drives the counter drum (35) and counter dial (36).

32. STOP-RING DRUM. See (12).

33. TUNED ELEMENT. The element, in this case an inductor tuning slug, is coupled directly to the stop-ring drum (32).

34. MULTITURN DIAL. This dial is equipped with a locking bar identical to that used to lock the singleturn dial (19). The multiturn stop rings may be locked in any position by operating the dial lock a fraction of a revolution in the clockwise direction.

35. COUNTER DRUM. The counter drum is made up of eleven cams and spacers. Like the stop-ring drums (12 and 32) the spacers are keyed to the shaft. A spring on the rear of the counter drum loads the stack of cams axially so that the rings will not turn too easily.

36. TURN COUNTER DIAL. The dial is fastened to the counter drum shaft. The numbers on the dial indicate the number of full revolutions of the stop-ring drum (32).

37. LIMIT SWITCH DRIVE SHAFT. The drive shaft is driven by the stop-ring drum spur gear (24) through the limit switch drive shaft spur gear (25). The switch operating arm (38) travels on the shaft and operates the limit switch (39).

38. SWITCH OPERATING ARM. The arm is threaded and travels on the limit switch drive shaft (37) when the shaft is rotated by the stop-ring drum (32) through gears (24 and 25).

39. LIMIT SWITCH. The limit switch is operated by the operating arm (38).

40. MULTITURN WORM #2. The worm drives the cam drum (46) through singletooth ratchet (15).

41. CAM DRUM WORM GEAR. This gear is driven by the line shaft (4) through the worm gear (40) and drives the cam drum (46) through the single tooth ratchet (15).

42. MULTITURN HOME STOP CAM. This cam is mounted with the other cams on the counter drum (35). The cam actuates the home stop pawl (43) and limits the rotation of the stop-ring drum (32) to 10 revolutions.

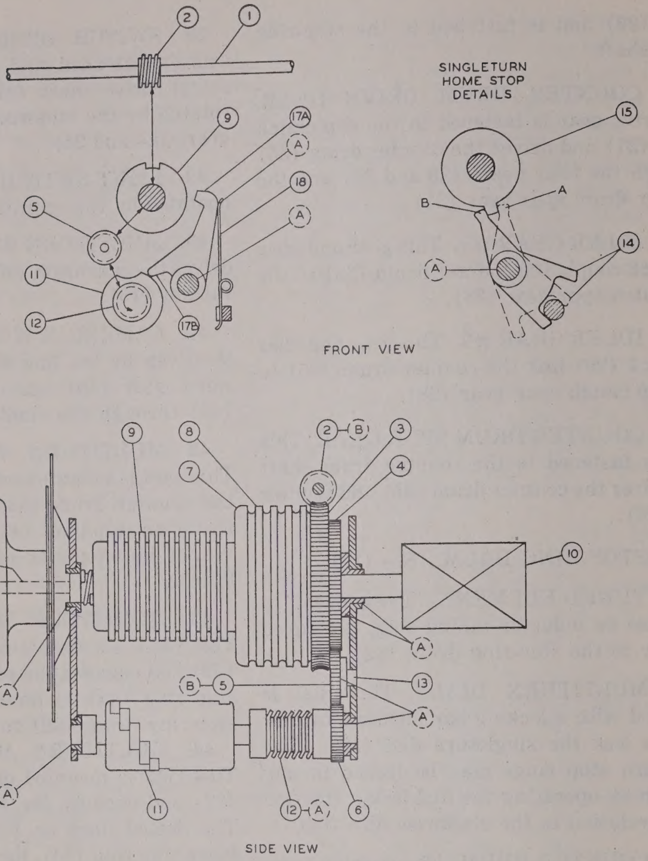
43. MULTITURN HOME STOP PAWL. This pawl is actuated by the home stop cam (42) and engages the projection on the home stop ring (44) to limit the rotation of the stop-ring drum (32) to 10 revolutions.

44. MULTITURN HOME STOP RING. This ring is mounted on the stop-ring drum (32) and engages the home stop pawl (43). The dotted lines on the drawing show the home stop ring (44), the home stop pawl (43) and the multiturn home stop cam (42) in the position corresponding to the maximum rotation in the counterclockwise direction. The solid outline shows the pawl in the position corresponding to the maximum rotation in a clockwise direction.

45. PAWL. This pawl engages the cam drum (46), the cam on the counter drum (35) and the stop ring of drum (32) to stop the tuned element in a position to which it has been previously set.

46. CAM DRUM. This drum is identical to cam drum (11).

47. PAWL SPRING. The pawl spring presses the pawl (45) against the cam drum (46) so that the projection on the pawl (45)



LUBRICATING INFORMATION

NOTE SEE MAINTENANCE SECTION OF INSTRUCTION BOOK FOR DIRECTIONS FOR LUBRICATION

SYMBOL	RECOMMENDED LUBRICANT
Ⓐ	VACTRA OIL, EXTRA HEAVY X
Ⓑ	VISCOLITE LUBRICANT #10

KEY TO SYMBOLS

1 LINE SHAFT
2 SINGLETURN WORM
3 SLIP CLUTCH WORM GEAR
4 CAM DRUM DRIVE SPUR GEAR
5 IDLER GEAR
6 CAM DRUM SPUR GEAR
7 SLIP CLUTCH BAND
8 SLIP CLUTCH DRUM
9 STOP RING DRUM
10 TUNED ELEMENT
11 CAM DRUM
12 DRIVE DOG
13 IDLER GEAR SHAFT
14 SINGLETURN HOME STOP PAWL
15 SINGLETURN HOME STOP RING
16 SINGLETURN KNOB
17 PAWL (17A TOE) (17B HEEL)
18 PAWL SPRING
19 T LOCKING BAR

Fig. 6 Heavy Duty Singleturn Unit—Mechanical Details
(Dwg. No. 500 0712 00C)

drops into the cam drum slot and permits the tooth of the pawl to engage the stop ring on the stop-ring drum (32).

48. PAWL ANVIL. The anvil prevents the multiturn pawl tails (45C) from becoming engaged with the counter drum (35) ring slots until after the motor (1) reverses.

(b) **Heavy-Duty Autotune Units.**

1. LINE SHAFT. The line shaft extends the entire length of the Autotune casting and drives all Autotune units within the casting. The line shaft is driven by the motor through the drive gears and the drive shaft.

2. SINGLETURN WORM. The singleturn worm drives the singleturn unit and is fastened to the line shaft (1) with a groov-pin.

3. SLIP CLUTCH WORM GEAR. This gear is fastened to the cam drum drive spur gear (4) and drives the stop-ring drum (9) through the slip clutch. The gear is driven by the singleturn worm (2).

4. CAM DRUM DRIVE SPUR GEAR. This gear is fastened directly to the slip clutch worm gear (3) and drives the cam drum spur gear (6) through the idler gear (5).

5. IDLER GEAR. This idler gear transmits power from the cam drum drive spur gear (4) to the cam drum spur gear (6).

6. CAM DRUM SPUR GEAR. The cam drum spur gear is driven by the line shaft through the singleturn worm (2), the cam drum drive spur gear (4), and the idler gear (5). The spur gear drives the cam drum (11) through the drive dog (12).

7. SLIP CLUTCH BAND. The band is driven directly from the slip clutch worm gear (2) and presses against the slip clutch drum (8).

8. SLIP CLUTCH DRUM. The clutch drum is fastened to the stop-ring drum shaft and is driven by the slip clutch band (7).

9. STOP-RING DRUM. The stop-ring drum assembly consists of 12 stop rings mounted on a shaft with spacers between the rings. The stop rings are free to rotate but the spacers are keyed to the shaft in such a manner that the rotation of a stop ring will not change the position of adjacent rings. The stop rings may be locked in position by rotating the locking bar on the front of the dial in a clockwise direction. The locking mechanism consists of a bar mounted on a screw that applies pressure to the stack of stop rings and spacers as the screw is rotated clockwise and thereby in effect locks the stop rings in position.

10. TUNED ELEMENT. The tuned element, capacitor, tuning slug, etc., is fastened rigidly to the stop-ring drum shaft.

11. CAM DRUM. The cam drum consists of 12 cams mounted on a shaft with adjacent cam slots staggered 30 degrees. These cams are rigidly fastened to the cam drum. The drive dog (12), mounted on the shaft behind the drum, drives the drum.

12. DRIVE DOG ASSEMBLY. The drive dog assembly is made up of six drive dogs held apart by spacers. The assembly is driven by the idler gear (5) and drives the cam drum (11).

13. IDLER GEAR SHAFT. This shaft is a bolt that is inserted through a hole in the rear plate.

14. SINGLETURN HOME STOP PAWL. The singleturn home stop pawl limits the rotation of the singleturn unit to one revolution. The pawl is located on the same shaft as the stop-ring pawl and is engaged by the singleturn home stop ring (15). The pawl, shown in solid lines on the drawing, limits the rotation of the stop-ring drum (9) in the counterclockwise direction.

15. SINGLETURN HOME STOP RING. This ring, mounted with the other stop rings on the stop-ring drum (9), is rigidly fastened to the drum. The home stop pawl (14) engages the ring to limit the rotation of the stop-ring drum (9) to one revolution.

16. SINGLETURN DIAL. The singleturn dial is fastened to the stop-ring drum (9) and

permits the calibration of the tuned element (10). The locking bar is located on the front of the dial and requires only a fraction of a revolution to lock or unlock the stop rings.

17. STOP-RING PAWL. The pawl is held against the cam drum by the pawl spring (18). The pawl serves to position the tuned element (10) by stopping the stop-ring drum (9) at the predetermined position.

18. PAWL SPRING. The pawl spring presses the pawl (17) against the cam drum (12) and when the pawl drops into the cam slot, the pawl spring presses the pawl against the stop-ring drum (9).

2.6.2. Electrical Details. Refer to Collins Autotune System—Electrical Details. The symbol designations opposite the description of the component correspond to the symbol designations that are used on the transmitter schematic diagrams and in the parts list. The following section has been compiled to aid the operator to better understand the operation and control of the Collins Autotune system. A brief description of each component associated with the system and a function of each is given below:

B101 **AUTOTUNE MOTOR.** This motor operates directly from the 230 volt 3 phase power source. The motor drives the Autotune mechanism through a series of drive and line shafts. The motor is controlled by the motor start relay, K104, and the motor reverse relay, K103.

K101 **OVERLOAD RELAY.** If the overload relay has been operated by an overload in the power amplifier circuit, any dialing operation will energize the reset coil and permit power to be applied to the high voltage supply.

K103 **MOTOR REVERSE RELAY.** When the circuit seeking switch, S108, has been operated to the position corresponding to the frequency channel that has been dialed, the motor reverse relay will be energized by the circuit through the contacts of the circuit seeking switch, the contacts of switch section S113D and the contacts of slow release relay #1, K107. The operation of relay K103 changes the connections of the Autotune motor and reverses the direction of rotation.

K104 **MOTOR START RELAY.** This relay causes the forward rotation of the Autotune motor by completing the connections to the 230 volt 3 phase power source. The motor start relay also serves as an interlock relay in the dialing circuit to prevent emission selection, channel selection and carrier application during the time that the motor is operating. Relay K104 may only be energized after the last dial impulse and the consequent release of the slow release relays, K107 and K108.

K105 **CW CONTROL RELAY.** The CW control relay is operated by dialing **A1.** If the automatic emission selector circuit is employed, relay K105 will be energized whenever the channel is selected that has been connected for automatic selection of CW emission. The CW control relay is held operated by the circuit through the contacts of K105 and the normally closed contacts of the pulsing relay. Any dialing operation will release the CW control relay.

K106 **TRANSMITTER OFF CONTROL RELAY.** The transmitter off control reley is operated by dialing **A0.** The operation of relay K106 breaks the circuit to the coil of the filament relay. The holding circuit for relay K106 is through the normally closed contacts of the pulsing relay. Any dialing operation will release relay K106 and permit the application of filament and plate power to the transmitter.

K107 **SLOW RELEASE RELAY #1.** Slow release relay #1 is operated by any dialing operation. The slow release characteristic of the relay holds the

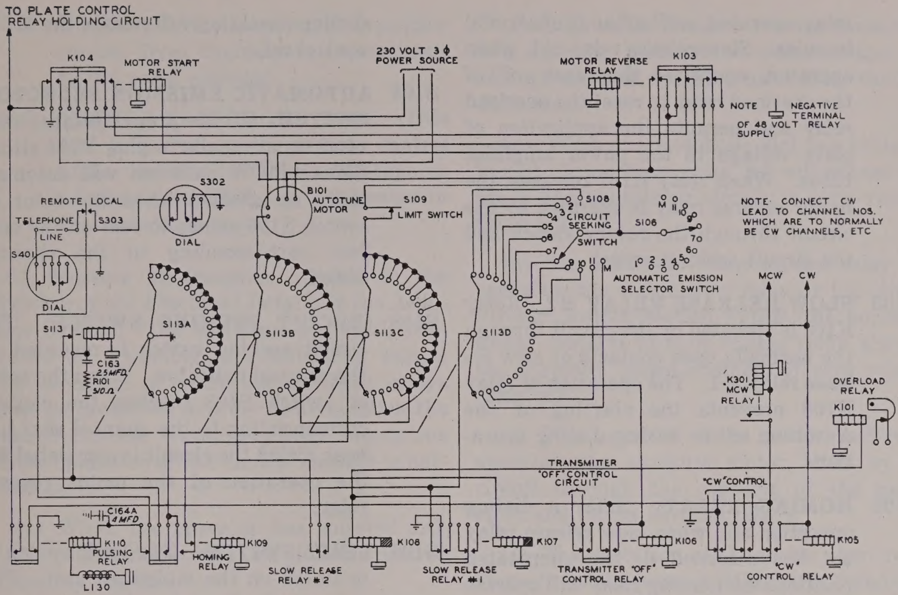
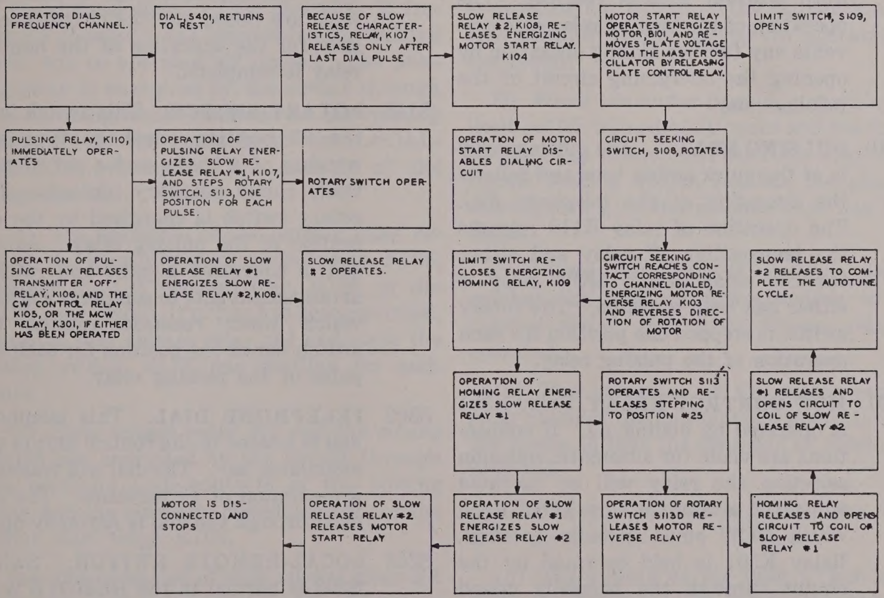

TO PLATE CONTROL RELAY HOLDING CIRCUIT
K104
MOTOR START RELAY
230 VOLT 3 ϕ POWER SOURCE
MOTOR REVERSE RELAY
K103
NOTE NEGATIVE TERMINAL OF 48 VOLT RELAY SUPPLY
S302
REMOTE
LOCAL
TELEPHONE LINE
S303
DIAL
S401
DIAL
B101 AUTOTUNE MOTOR
S109 LIMIT SWITCH
S108
CIRCUIT SEEKING SWITCH
S106
AUTOMATIC EMISSION SELECTOR SWITCH
M
NOTE: CONNECT CW LEAD TO CHANNEL NOS. WHICH ARE TO NORMALLY BE CW CHANNELS, ETC
MCW
CW
S113
S113A
S113B
S113C
S113D
C163 .25MFD
R101 510Ω
K301 MCW RELAY
OVERLOAD RELAY
K101
TRANSMITTER "OFF" CONTROL CIRCUIT
"CW" CONTROL
C164A 4MFD
K110 PULSING RELAY
L130
K109 HOMING RELAY
K108 SLOW RELEASE RELAY # 2
K107 SLOW RELEASE RELAY #1
K106 TRANSMITTER "OFF" CONTROL RELAY
K105 "CW" CONTROL RELAY

Fig. 7 Collins Autotune System—Electrical Details (Dwg. No. 500 0780 00C)



OPERATOR DIALS FREQUENCY CHANNEL.

DIAL, S401, RETURNS TO REST

BECAUSE OF SLOW RELEASE CHARACTERISTICS, RELAY, K107, RELEASES ONLY AFTER LAST DIAL PULSE

SLOW RELEASE RELAY #2, K108, RELEASES ENERGIZING MOTOR START RELAY. K104

MOTOR START RELAY OPERATES ENERGIZES MOTOR, B101, AND REMOVES PLATE VOLTAGE FROM THE MASTER OSCILLATOR BY RELEASING PLATE CONTROL RELAY.

LIMIT SWITCH, S109, OPENS

PULSING RELAY, K110, IMMEDIATELY OPERATES

OPERATION OF PULSING RELAY ENERGIZES SLOW RELEASE RELAY #1, K107, AND STEPS ROTARY SWITCH, S113, ONE POSITION FOR EACH PULSE.

ROTARY SWITCH OPERATES

OPERATION OF MOTOR START RELAY DISABLES DIALING CIRCUIT

CIRCUIT SEEKING SWITCH, S108, ROTATES

OPERATION OF PULSING RELAY RELEASES TRANSMITTER "OFF" RELAY, K106, AND THE CW CONTROL RELAY K105, OR THE MCW RELAY, K301, IF EITHER HAS BEEN OPERATED

OPERATION OF SLOW RELEASE RELAY #1 ENERGIZES SLOW RELEASE RELAY #2, K108.

SLOW RELEASE RELAY # 2 OPERATES.

LIMIT SWITCH RECLOSES ENERGIZING HOMING RELAY, K109

CIRCUIT SEEKING SWITCH REACHES CONTACT CORRESPONDING TO CHANNEL DIALED, ENERGIZING MOTOR REVERSE RELAY K103 AND REVERSES DIRECTION OF ROTATION OF MOTOR

SLOW RELEASE RELAY #2 RELEASES TO COMPLETE THE AUTOTUNE CYCLE.

OPERATION OF HOMING RELAY ENERGIZES SLOW RELEASE RELAY #1

ROTARY SWITCH S113 OPERATES AND RELEASES STEPPING TO POSITION #25

SLOW RELEASE RELAY #1 RELEASES AND OPENS CIRCUIT TO COIL OF SLOW RELEASE RELAY #2

MOTOR IS DISCONNECTED AND STOPS

OPERATION OF SLOW RELEASE RELAY #2 RELEASES MOTOR START RELAY

OPERATION OF SLOW RELEASE RELAY #1 ENERGIZES SLOW RELEASE RELAY #2

OPERATION OF ROTARY SWITCH S113D RELEASES MOTOR REVERSE RELAY

HOMING RELAY RELEASES AND OPENS CIRCUIT TO COIL OF SLOW RELEASE RELAY #1

Fig. 8 Autotune Operation Sequence (Dwg. No. 500 0780 00C)

relay operated until after the last dial impulse. Slow release relay #1, when operated, energizes the reset coil of the overload relay to reset the overload relay and permits the application of plate voltage to the power amplifier tubes. When relay K107 releases, the motor reverse relay is operated by the circuit through the rotary switch and the circuit seeking switch.

K108 **SLOW RELEASE RELAY #2.** Relay K108 is operated by the circuit through the normally open contacts of slow release relay #1. The operation of relay K108 prevents the starting of the Autotune motor during dialing operations.

K109 **HOMING RELAY.** After a dialing operation and when slow release relay #1 has returned to the unoperated position, the homing relay will operate to complete the circuit necessary for the operation of the rotary switch. The rotary switch will continue to operate until position #25 is reached. The operation of the homing relay also prevents any further dialing operation by opening the energizing circuit of the pulsing relay.

K110 **PULSING RELAY.** The pulsing relay is of the quick acting type and follows the operation of the telephone dial. The operation of relay K110 releases the transmitter off relay and either the CW relay or the MCW relay if either has been operated. The rotary switch is stepped one position for each operation of the pulsing relay.

K301 **MCW CONTROL RELAY.** Relay K301 is operated by dialing A2. If connections are made for automatic emission selection the relay will be operated whenever a channel is selected upon which MCW emission is to be used. Relay K301 is held operated by the circuit through the normally closed contacts of the pulsing relay. Any dialing operation will release the MCW control relay.

S106 **AUTOMATIC EMISSION SELECTOR SWITCH.** If the proper jumper connections are made in plug P104 either CW or MCW emission will automatically be selected when the rotor of switch S106 comes to rest on the contact corresponding to the channel dialed.

S108 **CIRCUIT SEEKING SWITCH.** The circuit seeking switch is mounted on the channel indicator. When the rotor of switch S108 reaches the contact corresponding to the channel that has been dialed the circuit is completed for the operation of the motor reverse relay.

S109 **LIMIT SWITCH.** The limit switch is mounted on the multiturn unit. The contacts are immediately opened when the motor begins to rotate. When the motor has reversed and returned to the original position the switch contacts are closed and the circuit necessary for the operation of the homing relay is completed.

S113 **ROTARY SWITCH.** This switch is of the 25 position telephone type and consists of 4 banks and a set of normally closed auxiliary contacts. The rotary switch is energized by the operation of the pulsing relay. As the coil is energized a pawl and ratchet arrangement acts to compress a spring which when released rotates the switch banks one position for each impulse of the pulsing relay.

S302 **TELEPHONE DIAL.** This telephone dial is located in the control unit in the modulator bay. The dial will transmit a maximum of 11 impulses. The circuit through the dial is normally open.

S303 **LOCAL-REMOTE SWITCH.** Switch S303 is normal in the REMOTE position. Operating the switch to the

LOCAL position transfers transmitter control from the remote control unit to the panel controls.

S401 **REMOTE TELEPHONE DIAL.** This dial is located in the remote control unit. The dial is of the same type as telephone dial S302, the dial located in the modulator bay.

2.6.3. Sequence of Operation. Refer to the drawing of the Electrical Details of the Autotune System. The Autotune system is controlled by a number of interlocking relays. The sequence of operation of these relays must be preserved in order to accomplish the desired results. A step-by-step description of the operation of the control circuits is outlined below:

(a) When the operator has selected LOCAL or REMOTE control, he dials the desired frequency channel.

(b) As the dial returns toward the rest position, the pulsing relay will be operated a number of times corresponding to the number of the channel dialed. (For example: If frequency channel 6 has been dialed the pulsing relay will be operated six times.) The pulsing relay is energized by the circuit through the normally closed contacts of the homing relay, K109, the contacts of the LOCAL-REMOTE switch and the contacts of the telephone dial.

(c) The operation of the pulsing relay releases the transmitter off control relay, K106, releases the CW control relay, K105, or the MCW relay, K301, if either has been operated, operates slow release relay #1 and steps the rotary switch, S113, one position for each pulse.

(d) Slow release relay #1 and the rotary switch are energized by the circuit through the normally open contacts of the pulsing relay and the normally closed contacts of the motor start relay, K104.

(e) The operation of slow release relay #1 energizes slow release relay #2 and resets the power amplifier overload relay, K101.

(f) Because of the slow release characteristic of relay K107, slow release relays #1 and #2 are held operated until after the last dial pulse.

(g) When the telephone dial has returned to rest, slow release relay #1 will release and break the energizing circuit to slow release relay #2.

(h) The release of slow release relay #2 energizes the motor start relay by the circuit through switch section S113B, the normally closed contacts of slow release relay #2 and the normally closed contacts of slow release relay #1.

(i) The operation of the motor start relay energizes the Autotune motor, B101, by the circuit through the contacts of the motor start and motor reverse relays.

(j) The operation of the motor start relay opens the plate power holding circuit and prevents the turning on of the r-f carrier during the time that the motor is operating.

(k) The limit switch, S109, the circuit seeking switch, S108, and the automatic emission selector switch, S106, are operated by the motor.

(l) When the motor begins to operate, the limit switch immediately opens and the motor continues to rotate until the rotor arm of the circuit seeking switch reaches the position corresponding to the channel that has been dialed.

(m) When the circuit seeking switch reaches the position corresponding to the channel dialed, the motor reverse relay is operated.

(n) The operation of the motor reverse relay changes the power input connections to the motor so that the direction of rotation is reversed.

(o) The motor reverses until the limit switch is closed.

(p) The closing of the limit switch energizes the homing relay, K109, through the contacts of switch section S113C, the contacts of the limit switch, the contacts of the circuit seeking switch, the contacts of switch section S113D and the normally closed contacts of slow release relay #1.

(q) The operation of the homing relay energizes slow release relay #1 by the circuit through the auxiliary contacts of the rotary switch, the normally open contacts of the homing relay and the contacts of rotary switch section S113A.

(r) The operation of slow release relay #1 energizes slow release relay #2.

(s) The operation of slow release relay #2 releases the motor start relay to stop the Autotune motor.

(t) The rotary switch also is energized by the operation of the homing relay and operates and releases, stepping to position #25.

(u) The operation of rotary switch releases the motor reverse relay.

(v) The operation of the rotary switch to position #25 releases the homing relay and slow release #1.

(w) The release of slow release relay #1 releases slow release relay #2 and completes the Autotune cycle.

2.7. RADIO FREQUENCY CIRCUITS. Refer to Transmitter Cabling and Complete Schematics in the APPENDIX Section of this book. The radio frequency system of this transmitter covers the frequency range 2000 kc to 18,100 kc. The frequency is controlled by a master oscillator. The master oscillator stage is followed by an r-f amplifier, an r-f multiplier, an r-f amplifier-tripler, an intermediate amplifier and a power amplifier. The combination power amplifier plate tuning and antenna coupling network is designed to feed an unbalanced antenna system.

2.7.1. Master Oscillator. The master oscillator employs a Type 6A8 pentagrid tube in a transitron oscillator circuit. The transitron oscillator gives output of good wave form and excellent frequency stability.

The oscillator operates within the frequency range 1000 kc to 1510 kc. The frequency of the output is determined by the position of the tuning slug within inductor L104. The tuning slug is connected to a precision lead screw which is operated by the Autotune Multiturn Unit. The position of the tuning slug in relation to the lead screw may be adjusted to set one of the end points of the frequency band. Ten revolutions of the Multiturn Unit tunes the oscillator circuit to give output on any frequency within the range 1000 kc to 1510 kc.

In this application grid #2 (G_2) of the Type 6A8 operates as the anode of the primary oscillator circuit. Grid #4 (G_4) operates as the control grid of the primary oscillator circuit. This configuration of grid and anode gives a negative transconductance characteristic. The output of the oscillator section of V101 is coupled by the electron stream to the plate of the Type 6A8 tube. The output of V101 is controlled by applying enough bias to the control grid (G_1) to cause the output of the oscillator to drop to zero whenever the circuit through the telegraph key, microphone push-to-talk switch and the test key is open. The necessary bias voltage for application to the grid of V101 is developed across resistor R119 when the keyer tube, V109, is drawing plate current. When the telegraph key, the microphone push-to-talk switch or the test key is operated, a negative voltage from the transmitter bias supply or remote control unit is applied to the control grid of V109, stopping the flow of plate current and reducing the voltage that is developed across resistor R119 to zero. Thus, with the fixed bias removed from the control grid, V101 will oscillate. Keying speeds of several hundred words per minute are possible with this type of carrier control.

To further improve the frequency stability of the oscillator tube, V101, the oscillator circuit components have been enclosed in a shielded compartment. The compartment is kept at a constant temperature by heater resistors R102 and R103 and the thermostat, S110. High voltage for application to the

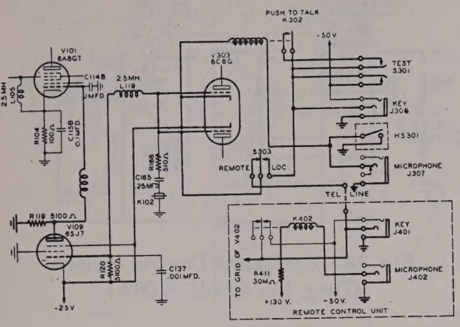


Fig. 9 Simplified Carrier Control Circuits
(Dwg. No. 500 0736 00A)

plate, screen grid and anode grid of the oscillator is supplied by the low voltage supply that is located in the Power Supply Unit. The voltage regulator tube, V107, keeps the voltage that is applied to the screen grid and anode grid of V101, constant even though the supply voltage may vary.

2.7.2. R-F Amplifier. Refer to the Transmitter Cabling and Complete Schematics in the APPENDIX Section of this book. The output of the oscillator is fed to the grid of the untuned r-f amplifier stage. The amplifier stage employs a Type 6AG7 pentode tube. Screen and plate voltages for the r-f amplifier, V102, are supplied by the low voltage power supply and dropped to the required values by the voltage divider consisting of resistors R143, R125, R126, and R127, and the screen resistor, R106. The tube is self-biased by the voltages that are developed across resistors R105 and R113.

2.7.3. Frequency Multiplier. The frequency multiplier stage employs a Type 807 beam pentode tube. The output of the r-f amplifier is coupled to the grid of V103 by capacitor C123. Switch sections S102A and S102B are operated by the EXCITER BAND SWITCH. When the EXCITER BAND SWITCH is operated to Position 4 (2.0 mc to 3.0 mc) V103 operates as a frequency doubler. When the control is operated to Position 3 (3.0 mc to 6.0 mc) V103 operates as a frequency tripler in the frequency range 3.0 mc to 4.5 mc, and as a frequency quadrupler in the range 4.5 mc to 6.0 mc. When the control is operated to Position 2 (6.0 mc to 9.0 mc) V103 operates as a frequency doubler and when the control is operated to Position 1 (9.0 mc to 18.1 mc) V103 operates as a frequency tripler in the frequency range 9.0 mc to 13.5 mc and as a frequency quadrupler in the range 13.5 mc to 18.1 mc. The plate tank tuning capacitor, C127, is operated by the EXCITER TUNING control and is ganged with the amplifier-tripler plate tank tuning capacitor, C132. Trimmer capacitor C138 has been provided to aid in obtaining proper tracking of the plate tank circuits.

The full voltage of the low voltage power supply is shunt fed to the plate of V103 through choke L109. Screen voltage is obtained from the same supply but is dropped through resistors R117, R118 and R127. The screen voltage is increased as the EXCITER BAND SWITCH is operated from Position 4 toward Position 1 by shorting out dropping resistors R117 and R118. Switch section S102C is operated by the EXCITER BAND SWITCH. When the control is operated to Positions 4 and 3, both dropping resistors R117 and R118 are in series with the screen lead. When the EXCITER BAND SWITCH is operated to Position 2, resistor R117 is shorted out to increase the screen voltage that is applied to V103 and V104 and when the control is operated to Position 1 both resistors R117 and R118 are shorted out to further increase the screen voltage. Increasing the voltage that is applied to the screen has the effect of increasing the output of the frequency multiplier and r-f amplifier-tripler stages. More excitation is necessary to drive V104 when the tube is operated as a frequency tripler. The output of the frequency multiplier is coupled to the grid of V104 by capacitor C128.

2.7.4. R-F Amplifier-Tripler. The Type 807 beam pentode tube, V104, operates as a straight amplifier when the transmitter is operated within the frequency range 2.0 mc to 6.0 mc and as a frequency tripler when operating within the frequency range 6.0 mc to 18.1 mc. Switch sections S103A, S103B, S103C, and S104A, operated by the EXCITER BAND SWITCH, select the proper plate tank inductor for the band of frequencies that includes the frequency upon which operation is desired. Tuning slugs within the inductors permit the adjustment of the inductance of the tank circuit to obtain tracking between the intermediate amplifier plate tank circuit and the preceding stages. The plate tank tuning capacitor, C132, is ganged with the frequency multiplier plate tank tuning capacitor, C127, and is operated by the EXCITER TUNING control.

This stage is connected so that a combination of fixed and self bias is applied to V104. Fixed grid bias is furnished by the bias supply located in the Power Supply Unit. The excitation to V104 may be checked by operating switch S105, located on top of the r-f unit chassis, to the position designated as "807," and reading the grid current on the EXCITER GRID CURRENT meter, M101. Operating switch S105 to the "807" position connects meter M101 in series with the lead from the bias supply to the grid of V104 and connects the meter shunting resistor R142 across M101.

Screen and plate voltages for the r-f amplifier-tripler are furnished by the low voltage supply. Voltage for the screen is dropped through resistors R117, R118, and R127. When operating in the frequency range 6.0 mc to 18.1 mc (EXCITER BAND SWITCH Positions 1 and 2) V104 is operated as a frequency tripler and, therefore, in order to keep the output near the same value as when operating in the frequency range 2.0 mc to 6.0 mc, the screen voltage that is applied to the intermediate amplifier is increased by shorting out the dropping resistors. When the EXCITER BAND SWITCH is operated to Position 2 (6.0 mc to 9.0 mc) only resistor R117 is shorted out. When the control is operated to Position 1 (9.0 mc to 18.1 mc) both resistors R117 and R118 are shorted out. The full output voltage of the low voltage power supply is shunt fed to the plate of V104 through choke L113.

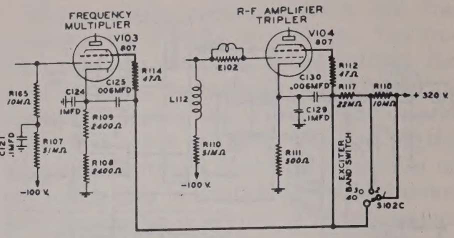


Fig. 10 Excitation Control Circuit
(Dwg. No. 500 4376 00A)

It will be noted that the screen voltage for V103 and V104 is obtained through common series dropping resistors R117, R118 and R127. As the drive to V104 increases the screen current of V104 increases causing a greater voltage drop across the series dropping resistors. This lower screen voltage is then applied to V103 which in turn lowers the drive to V104 giving automatic excitation control.

2.7.5. Intermediate Amplifier. The intermediate amplifier circuit employs two Type 813 beam pentode tubes in a parallel connected circuit. The output of the r-f amplifier-tripler section is coupled to the grids of V105 and V106 by capacitor C177. Fixed bias for the tubes is furnished by the bias supply. The grid current may be metered by operating switch S105 to the position designated as "813." Operating switch S105 to the "813" position connects the EXCITER GRID CURRENT meter, M101, in series with the lead from the bias supply to the grids of V105 and V106 and connects the meter shunting resistor, R116, across the meter.

The neutralizing circuit consists of capacitors C117 and C131. Capacitor C133 has been connected in series with C117 and re-

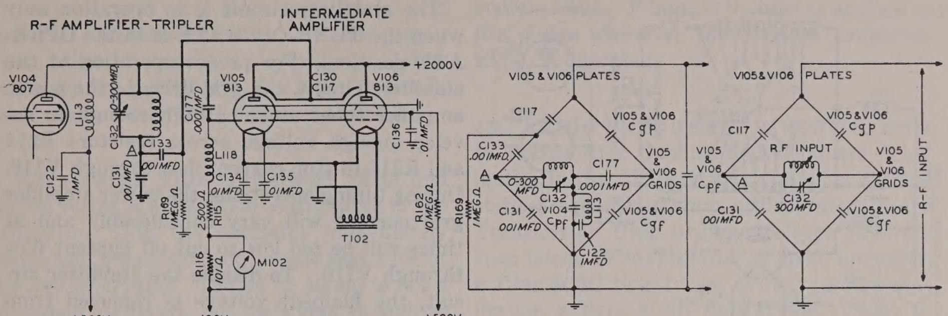


Fig. 11 Int. Amplifier Neutralization Circuit (Dwg. No. 502 0184 003)

sistor R169 has been connected between the junction of capacitors C117 and C133 and ground to protect the operating personnel from the shock due to the low voltage potential which would otherwise be applied to capacitor C117.

Refer to Fig. 11 Int. Amplifier Neutralization Circuit. The actual circuit is shown on the left. A network representation of the same circuit is shown in the center and the effective components in the neutralization circuit are shown on the right. The network shown in the center contains all of the circuit components that affect the neutralization of the Int. amplifier circuit. Capacitor C133 is very large in comparison to C117 and because the two capacitors are in series the effective capacity from the PLATES of the tubes to Point A is really the capacity of capacitor C117. Resistor R169 is a very high impedance and therefore has negligible effect upon the circuit. Capacitor C177 is very large in comparison to the effective capacity of the circuit made up by V104 C_{pf} (capacity plate to filament), L113 and C122 so that this capacity is effectively in parallel with V105 and V106 C_{gf} (capacity grid to filament).

The drawing on the right shows the simplified circuit with only the effective capacities. Theoretical balance of the circuit is obtained when C117 $\times$ C_{gf} (capacity grid to filament) $=$ C131 $\times$ C_{gp} (capacity grid to plate).

2.7.6. Power Amplifier. The power amplifier circuit employs two Type 750TL transmitting triodes (V114 and V115). The tubes are connected in parallel with the grids fed by the parallel connected intermediate amplifier stage. The full output voltage of the bias supply is applied to the grids of the power amplifier tubes and is fed through choke L101 and grid inductors L128B and L129. The full output voltage of the high voltage rectifier supply is applied to the plates of V114 and V115 through choke L122. The grid tank circuit consisting of L127, L128A, L128B, L129 and capacitor C105 permits the tuning of the grid circuit for maximum excitation. The amount of inductance in the grid circuit may be varied by the operation of the INT. AMP. BAND SWITCH and the circuit may be tuned by the operation of the INT. AMP. PLATE Tuning Control. The INT. AMP. PLATE Tuning Control operates variable capacitor C105. Neutralizing capacitor C157 is of the semi-variable type. Capacitor C157 consists of two parallel discs. The gap between the discs may be varied by moving one disc with respect to the other.

2.7.7. Power Amplifier Stabilizer. The Type 750TL tubes require stabilization the instant the drive is removed. The instant the key is opened or microphone switch is released the grid voltage on the tubes is such that unless the grid circuit is loaded the plate current of the power amplifier tubes will rise to a value

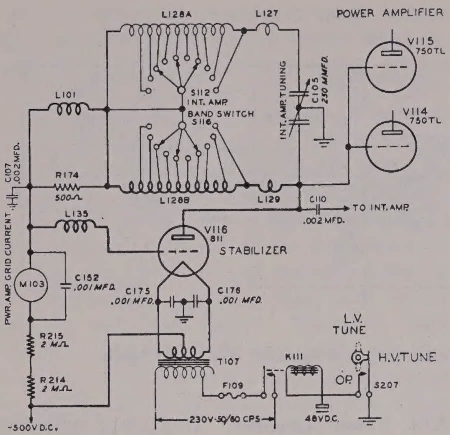


Fig. 12 P.A. Stabilizer Circuit
(Dwg. No. 500 4377 00B)

that will damage the tubes. If not stabilized, the plate current of the 750TL's may rise to a value that will damage the tubes.

A vacuum tube load is connected in the grid circuit of the power amplifier to stabilize the stage. A high mu transmitting triode (Type 811) is used as an electronic load across the grid circuit. The plate of V116 is connected to the grids of the power amplifier tubes (V114 and V115) and the grid of the Type 811 tube is connected between the power amplifier grid resistors and the grid network. The center tap of the stabilizer filament transformer is connected to the bias supply. Thus with no drive to the grids of the power amplifier tubes, the grids of the power amplifier tubes and the grid and plate of the stabilizer tube are all at the same potential (-500 volts).

During the time that the key is closed an additional 600 volts of bias is developed across the grids resistors R214 and R215. With -1100 volts applied to grid of V116, the plate resistance of the stabilizer tube becomes so high that the operation of the power amplifier is not affected by electronic load across the grid circuit. The instant that the key is opened the voltage on the grid of V116 drops to -500 volts (the same as on the cathode) and a load is applied to the grids of the power amplifier tubes.

The stabilizer circuit is in operation only when the TUNE-OPERATE is in the OPERATE position. For proper operation of the stabilizer circuit, the grid drive to the power amplifier tubes must be high enough to develop enough voltage across resistors R214 and R215 to stop current flow through V116. During tuning operations, the power amplifier grid current will vary considerably and at times will be too low to cut off current flow through V116. To disable the stabilizer circuit, the filament voltage is removed from V116 when the TUNE-OPERATE switch is operated to the H.V. TUNE position.

2.7.8. Output Network. A pi network is used as a combination power amplifier plate tank circuit and antenna coupling network in this transmitter. The output of the power amplifier stage is coupled to the network by capacitor C155. The POWER AMP. BAND SWITCH operates switch S111 and shorts out sections of inductor L125 as the control is operated from position 10 to position 2. A high frequency inductor L123 is connected in series with inductor L125 to permit operation in the high frequency end of the frequency range 2000 kc to 18,100 kc. When the control is operated to Position 1 only a part of inductor L123 is in the circuit; inductor L125 is shorted out. The network input capacitor, C158, is operated by the POWER AMP. TUNING Control. Capacitor C159, connected across the output side of the pi network, is operated by the ANTENNA LOADING Control. The output of the network is connected to the antenna terminal on the roof of the r-f bay. An external r-f ammeter, M105, is mounted on the antenna terminal and in series with the lead to the antenna feeder.

2.8. CRYSTAL FREQUENCY INDICATOR. Refer to the Transmitter Cabling and Complete Schematics in the APPENDIX of this book. The master oscillator calibration unit employs three tubes, a Type 6A8GT as a converter (V111), a Type 6SL7GT as a frequency multiplier (V110), and a Type 6SN7GT as an audio amplifier (V113).

The oscillator section of V111, consisting of cathode grid #1 (G_1) and anode grid #2 (G_2), operates on 200 kc. The frequency upon which the oscillator operates is determined by the quartz crystal Y101. The oscillator tank circuit, Z101, is tuned to 200 kc.

When switch S101 is operated, plate and screen voltages are applied to the tubes in the calibration unit, the oscillator immediately starts and generates a 50 kc sub-harmonic of the 200 kc crystal. The 50 kc signal is not a sustained oscillation but lasts long enough to excite one triode section of V110 at 50 kc. The frequency of the signal is tripled in V110 to give a 150 kc signal. The output of the frequency multiplier section of V110 is coupled to grid #4 of V111 and is beat with the 200 kc output of the crystal oscillator to produce a 50 kc beat note to feed the frequency multiplier section of V110 to maintain operation. The output of V111 is coupled to the grid of the frequency multiplier section of V110 and to the cathode of the mixer section of the same tube. A portion of the output of the master oscillator is coupled to the grid of the mixer section of V110 to beat against a harmonic of the 50 kc output of V111. The output of the mixer section of V110 and audio signal is coupled to one triode section of the dual triode V113 through tank circuit Z104. The dual triode operates as a two stage audio amplifier, the output of the first triode section of V113 being coupled to the remaining triode section of V113 by capacitor C147. The output of the audio amplifier is coupled to the PHONES jack, J106, by transformer, T106. Headphones with an impedance of from 500 ohms up to and including phones of the crystal type may be used satisfactorily.

Plate and screen voltages for tubes in the CFI unit are supplied by the low voltage power supply. Voltage is applied to the plate of V111 through tank circuit Z102, one plate of V110 through tank circuit Z103, and the other plate of V110 through tank circuit Z104. Plate and screen voltages are applied to the tubes by the operation of the CFI power switch, S101. Filament voltage is applied to the plates whenever the filament contactor, K205, is operated.

2.9. AUDIO FREQUENCY CIRCUITS. Refer to Transmitter Cabling and Complete Schematics in the APPENDIX of this book. The audio frequency system incorporated in the Transmitter Unit utilizes a Type 6SL7GT twin triode (V301) as the 1st audio amplifier, a Type 6C8G twin triode (V302) as a volume limiter, a Type 6C8G twin triode (V303) as an audio squelch tube, a Type 6SJ7 triple grid tube (V304) as 2nd audio amplifier, a Type 6X5GT full-wave rectifier (V306) as a limiter control tube, a pair of Type 801 triodes (V307 and V308) as an audio power amplifier stage, a pair of Type 845 triodes (V309 and V310) as audio drivers, and a pair of Type 450TL triodes (V311 and V312) as modulators. Two additional stages of audio amplification are incorporated in the remote control unit. A Type 6SJ7 triple grid tube (V401) is employed as first audio amplifier, and a Type 6SN7GT twin triode (V402) is employed in the second stage of amplification.

2.9.1. Remote Amplifier. A two stage audio amplifier is incorporated in the remote control unit to overcome the loss in the lines. Either of two input circuits to the amplifier may be used. The input transformer T401 has two primary windings, a 75 ohm winding and a 500 ohm winding. The 500 ohm transformer winding is brought out to terminal strip E401 on the rear of the unit. The MICROPHONE jack, J402, is connected across the 75 ohm winding so that a low impedance microphone may be used. Transformer T401 couples the output of the audio line or the microphone to the grid of the first preamplifier tube, V401, through the GAIN control, R401. Screen and plate voltages for V401 and V402 are furnished by the power rectifier, V403.

The output of the first amplifier stage is coupled to the grid of one triode section of the second amplifier tube, V402, by capacitor C402. The audio output of V402 is coupled

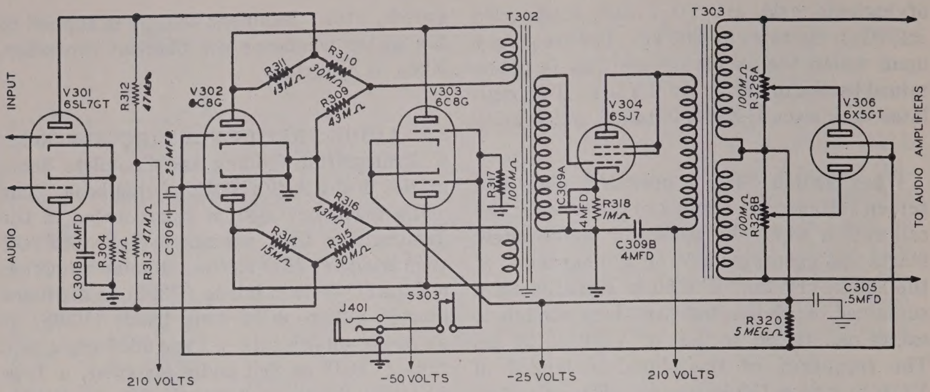


Fig. 13 Limiter and Audio Amplifier Circuits (Dwg. No. 500 0737 00A)

to the 500 ohm transmission line by transformer T402. Meter M402 is connected directly across the secondary of transformer T402 and indicates the level of the audio output of the remote amplifier unit.

The remaining triode section of V402 is utilized to operate the receiver disabling circuit. With current flowing through the triode section, relay K401 is held operated. When the carrier control circuit is closed a bias voltage is applied to the grid of V402 and the flow of plate current is stopped, releasing relay K401.

2.9.2. 1st Audio Amplifier. The first stage of the audio system that is incorporated in the modulator bay employs a Type 6SL7GT twin triode tube (V301) connected in a balanced circuit. Input transformer T301 couples the audio output of the transmission line or the local microphone to the grids of V301. With the LOCAL-REMOTE switch, S303, in the normal or REMOTE position, the output of the 500 ohm remote line is coupled directly to the primary of transformer T301. When switch S303 is operated to the LOCAL position connections are made from the MICROPHONE jack, J307, to the primary of the audio input transformer so that a local microphone may be used when it is desired to control the transmitter from a position near the installation.

The dual section potentiometer, R324, controls the input to the grids of V301. Plate voltage is furnished by the low voltage power supply through resistors R312 and R313. Cathode bias is developed across resistor R304.

2.9.3. Volume Limiter and 2nd Audio Amplifier. Refer to Fig. 13. The volume limiter that is incorporated in this equipment has been designed to control the audio signal level and to give uniform speech amplifier output with a relatively wide variation of audio input. When the limiter control is properly adjusted, increasing the input to the preamplifier as much as 25 db will cause a rise in the speech amplifier output which will not exceed 3 db. The limiter circuit utilizes the principle of the familiar Wheatstone resistance bridge.

The limiter circuit employs two Type 6C8G twin triodes (V302 and V303) and a Type 6X5GT full-wave rectifier (V305). The two Type 6C8G tubes are connected in a double resistance bridge circuit with the triode sections of V302 and V303 acting as the variable legs of the bridges. The double bridge circuit provides proper termination for the balanced output of the preamplifier stage. One bridge circuit consists of resistors R309, R310, R311, and a variable leg consisting of two triodes, one section of V302 and one section of V303, connected in parallel. The second bridge circuit consists of resistors R314, R315, and R316, and the remaining triode sections of the two Type 6C8G tubes. When the value of R309 × R311 = R310 × (the plate resistance of the vacuum tube leg of the bridge) and the value of R314 × R316 = R315 × (the plate resistance of the vacuum tube leg of the bridge), the loss across the bridge circuit will be very high and only a very small portion of the output of the preamplifier will be permitted to reach the primary winding of the interstage coupling transformer, T302. If, however, the resistance of one leg of the bridge is very high compared to the other three legs, the bridge will be unbalanced and the loss in the circuit will be small.

Tube V303 has been connected in the circuit to protect the modulator tubes during the time that the transmitter is in the stand-by condition, that is, with filament and plate voltages on but with the microphone push-to-talk button released, the telegraph key open and the TEST switch in the OFF position. During the time that the r-f carrier is off, V303 is in a conducting condition with approximately -30 volts on the cathodes and no fixed bias on the grid, resulting in a comparatively low value of plate resistance. With zero audio input, the bias on the grids of V302 is approximately –25 volts, resulting in a high value of plate resistance. With one triode section of V302 connected in parallel with a triode section of V303, the resistance of the variable bridge leg will be less than the plate resistance of the tube with the lower plate resistance. Under the conditions stated above the resistance of the variable leg will be less than the plate resistance of V303 and will be near the value necessary to balance the bridges. When the bridges are balanced very little voltage will appear across the windings of transformer T302 and the modulator tubes will be protected from damage as a result of driving the grids when the Class C load is removed.

When the r-f carrier is turned on by operating the TEST switch, telegraph key or the push-to-talk button on the microphone a fixed bias is applied to the grid of V303 so that the flow of plate current is cut off and the plate resistance of the tube becomes very high to unbalance the bridges and permit the output of the preamplifier stage to appear across the primary of transformer T302. The output of the preamplifier, V301, drives the grid of the triode connected Type 6SJ7 audio amplifier (V304). The output of V304 is coupled to the grids of the push-pull audio amplifier stage by transformer T303. The limiter tube, V306, is also connected across the secondary of transformer T303. The voltage that is applied to the plates of V306 may be varied by the adjustment of potentiometer, R326. As the level of the audio signal is increased, the voltage across the secondary of transformer T303 increases, resulting in an increase in the amount of current that flows in the rectifier circuit. The current flowing through the rectifier, V306, develops a voltage across resistor R320 which varies directly with the flow of current through the rectifier and is opposite in polarity to the fixed bias that appears across the resistor. The sum of the fixed bias voltage and the developed voltage gives a voltage that is less negative than the fixed bias that is ordinarily applied to V302 and the result is a greater flow of current through the limiter tube. Increasing the flow of plate current through V302 results in a lower plate resistance and resistance of the vacuum tube legs approaches the value that is necessary to balance the bridges. The loss across the bridge increases rapidly as balance is approached and as a result less voltage is permitted to reach the primary of transformer T302. The flow of current through V306 and the resulting amount of compression may be regulated by adjusting R326. Plate voltage for the limiter and audio amplifier tubes is furnished by the low voltage power supply.

2.9.4. Audio Power Amplifier. The audio power amplifier stage employs two Type 801 transmitting triodes in a push-pull circuit. The output of the second audio amplifier stage is coupled to the grids of V307 and V308 by transformer T303. The output of the audio power amplifiers is coupled to the grids of the

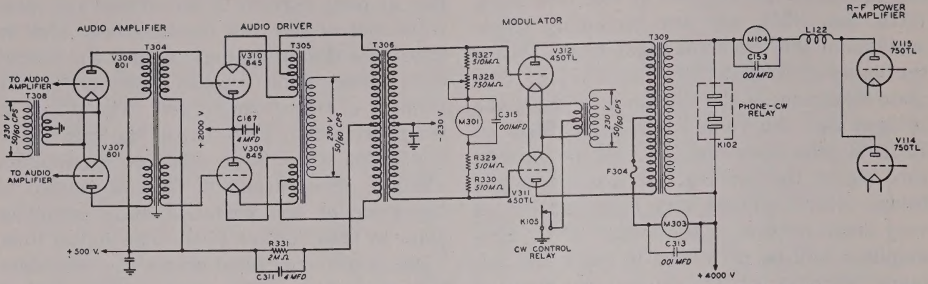


Fig. 14 Audio Driver and Modulator Circuit (Dwg. No. 502 0186 003)

audio driver tubes by transformer T304. The full output voltage of the low voltage power supply is applied to the plates of V307 and V308. This audio amplifier stage operates Class A. Fixed bias for the grids is furnished by the bias supply. The bias voltage is applied to the junction of grid resistors R321 and R322.

2.9.5. Audio Driver. Refer to Fig. 14. A cathode coupled push-pull audio driver is employed to drive the Class B modulator stage. The audio drive employs two Type 845 transmitter triodes (V309 and V310). By taking the output from the cathode circuit rather than the plate circuit a much lower impedance output is obtained, making it much easier to couple the output of the audio amplifier to the grids of the modulator tubes.

The output of the audio driver stage is coupled to the grids of the modulator tubes (V311 and V312) by transformers T305 and T306. Because the Type 845 tube is of the direct heater type, having no cathode, it is necessary to couple from the center taps of the filament transformer windings.

The actual potential difference between the cathodes and plates of V309 and V310 is considerably less than the voltage that is applied to the plates. The grids of the tubes are at a potential of approximately 500 volts above ground and cathode bias of between 200 volts and 300 volts is developed across resistor R331 by the static plate current so that the actual effective plate voltage under static conditions is between 1100 volts and 1300 volts. The voltage that is applied to the grids of V309 and V310 is furnished by the low voltage power supply and the plate voltage is obtained by connecting to the center tap of the plate power transformer, T203.

2.9.6. Modulator. Two Type 450TL transmitting triodes operating Class B are employed to modulate the output of the r-f power amplifier. The output of the audio driver stage is coupled to the grids of the modulator tubes, V311 and V312, by transformer T306. The bias voltage that is applied to the grids of V311 and V312 is supplied by the bias supply and is coupled through a rheostat. Thus the bias that is applied to the grids of the modulator tubes may be adjusted to obtain the best possible performance of the modulator stage. An audio level meter is connected across the input to V311 and V312 to aid in properly adjusting the audio stages. A variable resistor, R328, permits the adjusting of the voltage that is applied to meter M301. The output of the modulator tubes is coupled to the Class C load by modulation transformer T309. The full output voltage of the high voltage rectifier is applied to the plates of V311 and V312. During periods of CW transmission the filament voltage is removed from the filaments of the modulator and audio driver tubes by the operation of the Phone-CW relay, K102.

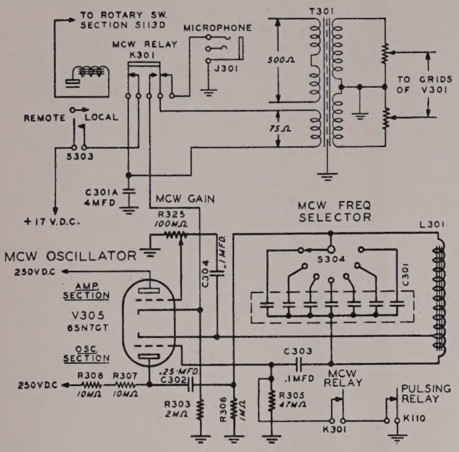
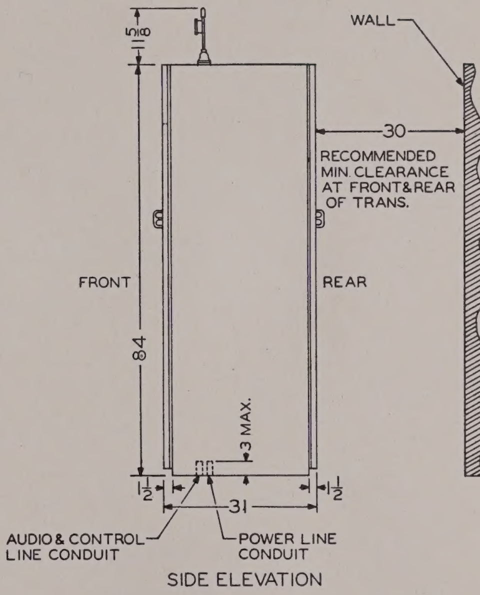


Fig. 15 MCW Oscillator-Amplifier Circuit (Dwg. No. 500 4378 00B)

2.9.7. MCW Oscillator. One triode section of the Type 6SN7GT tube (V305) operates as an MCW oscillator and the remaining triode section is connected so as to present a high impedance to the MCW oscillator and a low impedance to the 75 ohm winding of the audio input transformer. The oscillator plate tank circuit, consisting of reactor L301 and capacitor C310, may be tuned to any one of seven different frequencies in the range 400 cps to 1200 cps by operating switch S304. Capacitor C310 is made up of seven capacitor sections enclosed in a single case. Operating switch S304 changes the frequency of the output of the oscillator by varying the capacitance that is connected across reactor L301. The output of the oscillator section of V305 is coupled from the cathode to the grid of the remaining triode section of the same tube. The output of the MCW oscillator may be varied by operating potentiometer R325. Plate voltage for V305 is obtained from the low voltage power supply. When CW or VOICE emission is being used, the MCW oscillator is rendered inoperative by grounding the grid of the oscillator section of V305 through the normally closed contacts of relays K301 and K110. When MCW emission is selected by dialing A2, the ground is removed from the grid of the oscillator section of V305 and the circuit from the audio line to the speech amplifier input transformer, T301, is opened to prevent any audio signal except that of the audio oscillator from reaching the primary of the input transformer, T301. Resistor R306 provides cathode bias to the oscillator section of V305 during times that the tube is not oscillating.

PUT


11 5/8
WALL
30
RECOMMENDED MIN. CLEARANCE AT FRONT & REAR OF TRANS.
FRONT
REAR
84
3 MAX.
1 1/2
1 1/2
31
AUDIO & CONTROL LINE CONDUIT
POWER LINE CONDUIT
SIDE ELEVATION

POWER REQUIREMENTS
230 VOLTS, 3 PHASE, 60 CYCLE ALTERNATING CURRENT, APPROX. 10K.W. AT 85% POWER FACTOR.

AUDIO & CONTROL LINE REQUIREMENTS
TWO 500 OHM METALLIC PAIRS, WITH NOT OVER 25 D.B. LOSS OR MORE THAN 1000 OHMS LOOP RESISTANCE.

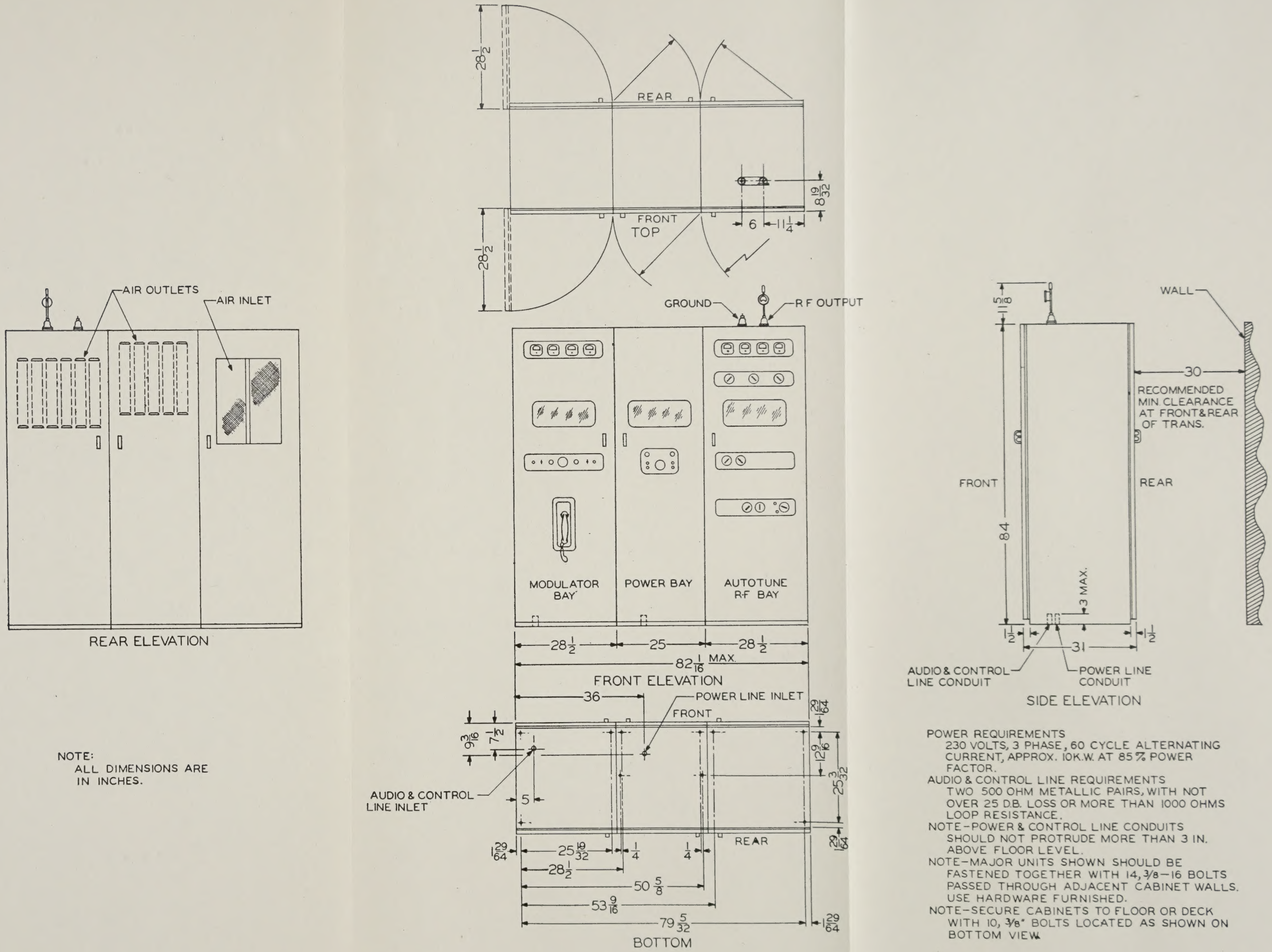
NOTE–POWER & CONTROL LINE CONDUITS SHOULD NOT PROTRUDE MORE THAN 3 IN. ABOVE FLOOR LEVEL.

NOTE–MAJOR UNITS SHOWN SHOULD BE FASTENED TOGETHER WITH 14, 3/8–16 BOLTS PASSED THROUGH ADJACENT CABINET WALLS. USE HARDWARE FURNISHED.

NOTE–SECURE CABINETS TO FLOOR OR DECK WITH 10, 3/8" BOLTS LOCATED AS SHOWN ON BOTTOM VIEW.

Fig. 16 Installation Diagram (Dwg. No. 425E)

5E)



NOTE:
ALL DIMENSIONS ARE IN INCHES.

POWER REQUIREMENTS
230 VOLTS, 3 PHASE, 60 CYCLE ALTERNATING CURRENT, APPROX. 10K.W. AT 85% POWER FACTOR.

AUDIO & CONTROL LINE REQUIREMENTS
TWO 500 OHM METALLIC PAIRS, WITH NOT OVER 25 D.B. LOSS OR MORE THAN 1000 OHMS LOOP RESISTANCE.

NOTE–POWER & CONTROL LINE CONDUITS SHOULD NOT PROTRUDE MORE THAN 3 IN. ABOVE FLOOR LEVEL.

NOTE–MAJOR UNITS SHOWN SHOULD BE FASTENED TOGETHER WITH 14, 3/8–16 BOLTS PASSED THROUGH ADJACENT CABINET WALLS. USE HARDWARE FURNISHED.

NOTE–SECURE CABINETS TO FLOOR OR DECK WITH 10, 3/8" BOLTS LOCATED AS SHOWN ON BOTTOM VIEW.

Fig. 16 Transmitter Installation Diagram (Dwg. No. 425E)

Fig. 16 Installation Diagram (Dwg. No. 425E)

3.1. **GENERAL.** Before placing the cabinets be sure that arrangements are complete (especially the power input conduit) for the external connections to the equipment. Refer to the drawing for the overall dimensions of the cabinets and the positions of the wiring ducts.

3.2. **EXTERNAL CONNECTIONS.** The external connections consist of 230 volt 50/60 cps 3 phase power input connections, the remote control lines and the radiation system.

3.2.1. **Power Line.** The transmitter requires a 230 volt 50/60 cps three phase power source. The power lines should be brought in through a conduit and in such a manner that the leads can be brought up through a grommet in the base of the power rectifier unit. Refer to the drawing.

A station switch should be installed in the power line to permit the complete disconnecting of the power from the transmitter.

The power line and station switch should be capable of carrying at least 30 amperes.

3.2.2. **Remote Lines.** Refer to the drawing for remote control unit and modulator bay terminal strip connections. The remote control unit is designed to control the transmitter over two cable pairs and a ground return circuit. The control system will function satisfactorily up to the distance where the line loss exceeds 25 db or the loop resistance of the line exceeds 1000 ohms. The channel indicator functions over the audio pair and the ground return.

3.2.3. **Radiation System.** It is recommended that vertical antenna systems be installed. Every effort should be made to choose antennas that do not have high reactive impedance

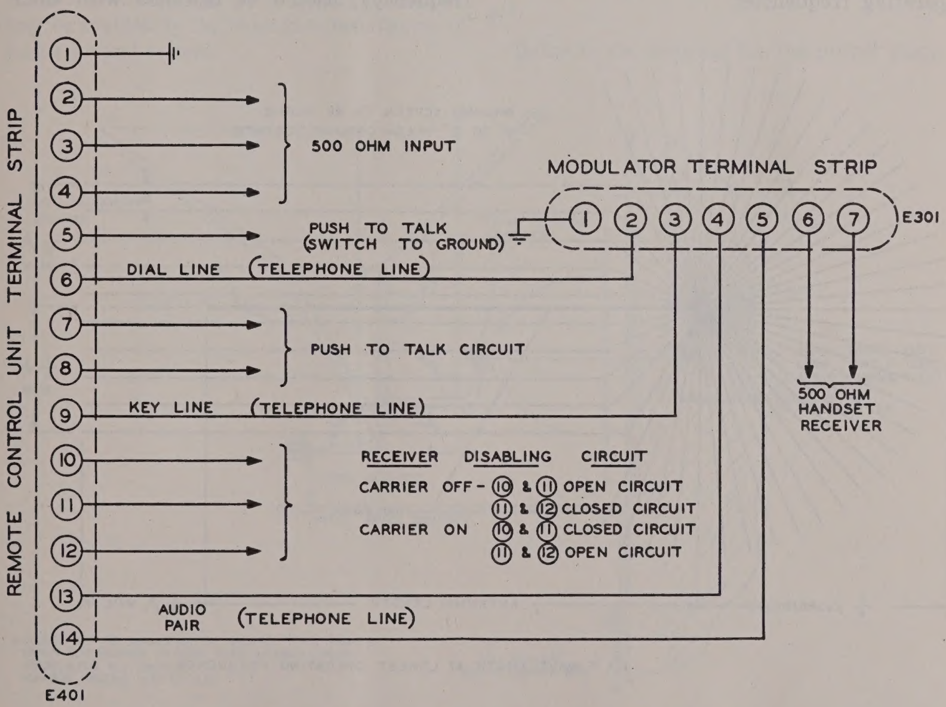

REMOTE CONTROL UNIT TERMINAL STRIP
1
2
3
4
5
6
7
8
9
10
11
12
13
14
E401
500 OHM INPUT
PUSH TO TALK (SWITCH TO GROUND)
DIAL LINE (TELEPHONE LINE)
PUSH TO TALK CIRCUIT
KEY LINE (TELEPHONE LINE)
RECEIVER DISABLING CIRCUIT
CARRIER OFF - ⑩ & ⑪ OPEN CIRCUIT
⑪ & ⑫ CLOSED CIRCUIT
CARRIER ON ⑩ & ⑪ CLOSED CIRCUIT
⑪ & ⑫ OPEN CIRCUIT
AUDIO PAIR (TELEPHONE LINE)
MODULATOR TERMINAL STRIP
E301
500 OHM HANDSET RECEIVER

Fig. 17 External Connections (Dwg. No. 500 0278 00A)

components. Maximum impedance can be decreased by the use of an antenna conductor having a relatively large cross section. A conductor with a diameter of ⅜ inch will appreciably reduce the reactances encountered. Conductors of greater diameter, such as ¾ to 2 inches, will further improve multi-frequency operation. The height of a vertical radiator should be determined for the lowest operating frequency. It should be at least one-quarter wavelength at this frequency.

For an end fed antenna, the ratio of the length of the vertical portion to the horizontal portion should be as large as possible. Whenever possible, the height of the antenna should be near one-quarter wavelength at the lowest frequency. The total length of the antenna, including the vertical portion or lead end, should be adjusted to avoid the immediate vicinity of a half wavelength or multiple of a half wavelength at any of the operating frequencies.

The efficiency of the radiation system is largely dependent upon the ground system used. In case of a vertical radiator, sixty radials of number 8 to 10 gauge bare copper wire spaced 6 degrees apart and terminated at a common heavy conductor as near the base of the radiator as possible should be used. The length of these radials should be at least a quarter wavelength referred to the lowest operating frequency. The connections from this ground mat to the transmitter ground terminal at the base of the cabinet should be made by means of a heavy copper conductor.

For a single wire, end fed horizontal antenna, the ground system shown in Fig. 18 is recommended. A system of radial wires of 8 or 10 gauge bare copper spaced 6 degrees apart covering approximately 225 degrees and extending for approximately a quarter wavelength (referred to the lowest operating frequency), should be installed with their

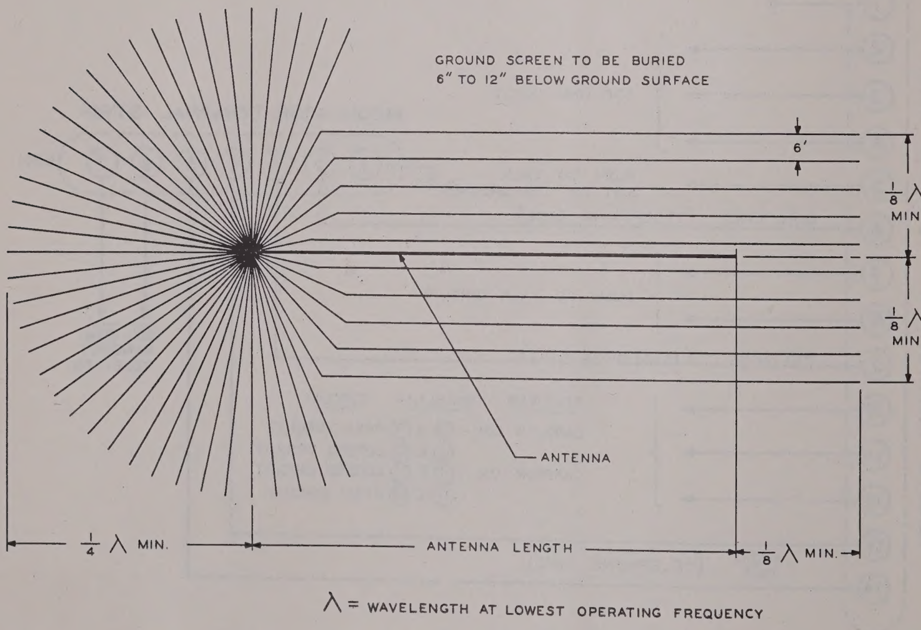

GROUND SCREEN TO BE BURIED
6" TO 12" BELOW GROUND SURFACE
6'
1/8 λ MIN.
1/8 λ MIN.
ANTENNA
1/4 λ MIN.
ANTENNA LENGTH
1/8 λ MIN.
λ = WAVELENGTH AT LOWEST OPERATING FREQUENCY

Fig. 18 Ground System (Dwg. No. 500 0034 00A)

center directly below the vertical or feedline portion of the antenna. The area covered by the radials should be that portion opposite the open end of the horizontal junction or center of the radial system should be a group of wires spaced five or six feet apart, laid parallel with the horizontal portion of the antenna and extending for at least an eighth wavelength, referred to the lowest operating frequency, beyond the open end of the antenna and approximately an eighth wavelength in the direction normal to the horizontal portion of the antenna. A separate ground plate should be installed as near the transmitter cabinet as possible and a connection from this ground made directly to the cabinet.

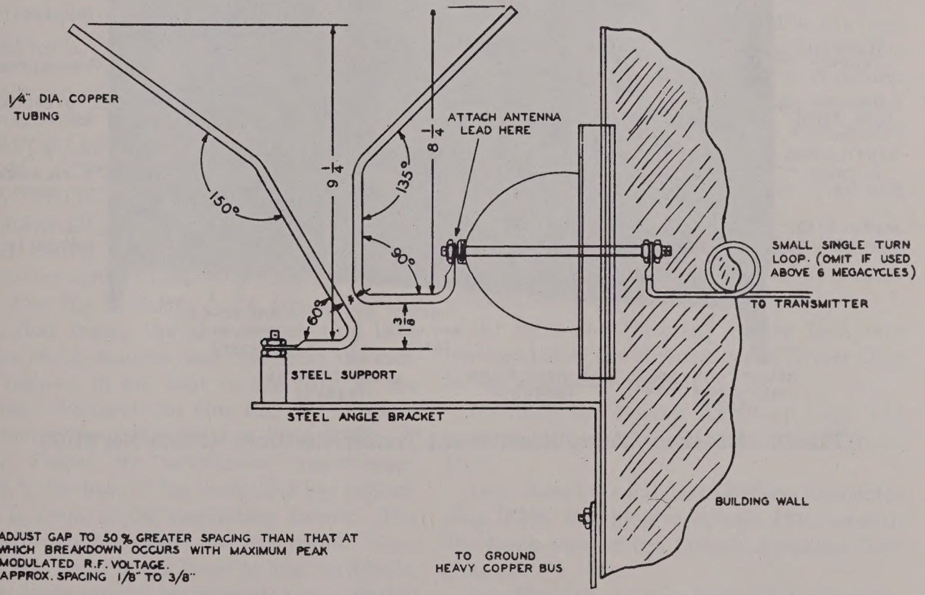
The use of a suitable ground system such as outlined above will improve the radiating efficiency of the installation and will reduce excessive radio frequency voltages appearing in the control circuits, particularly the telephone line control equipment. **Many difficulties may be avoided by the immediate installation of such a ground system.**

At the building entrance for the antenna, a horn gap should be installed to reduce the danger of damage to the equipment due to electrical storms or disturbances. A suitable horn gap is shown in Fig. 19.

3.3. **UNCRATING.** The units were removed from the cabinets when the equipment was packed for shipment. If any of the cabinets or units have been damaged in shipment the original packing crate and packing material should be preserved and a claim for damage filed promptly with the transportation company.

The large cabinets and vertical chassis should be unpacked first. When bolted together the three bays require a space 31″ deep by 82¹⁄₁₆″ wide and 95⅝″ high. In addition, a clearance of 28½″ is necessary in the front and the rear of the cabinets to allow the doors to open and to permit the free circulation of air.

Refer to the drawing for the proper place-



* ADJUST GAP TO 50% GREATER SPACING THAN THAT AT WHICH BREAKDOWN OCCURS WITH MAXIMUM PEAK MODULATED R.F. VOLTAGE.
APPROX. SPACING 1/8" TO 3/8"

Fig. 19 Horn Gap Installation (Dwg. No. 1707A)

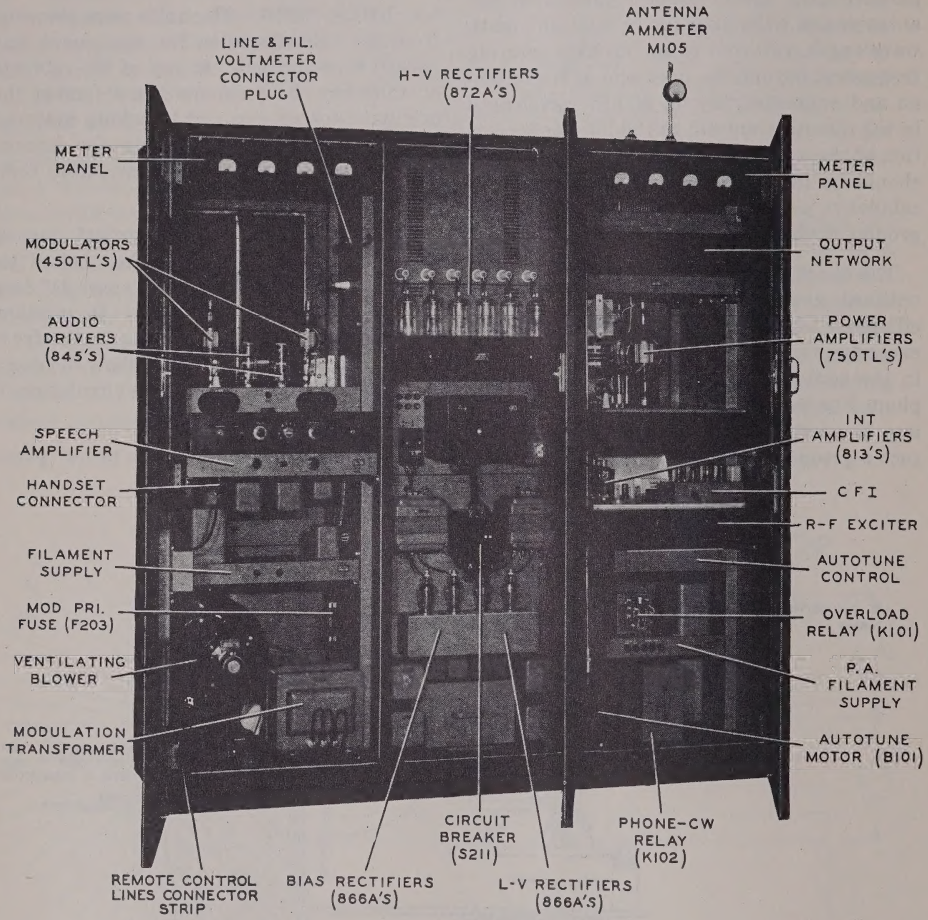


Fig. 20 Modulator, Power Rectifier and Transmitter Units (Photo No. 8707)

ment of the cabinets. First place the Navy Type COL-20196 Rectifier Power Unit in position. Using a hoist, lift the high voltage transformer, T203, into place on the rear platform of the vertical chassis. The Navy Type COL-50129 Modulator Cabinet should be placed on the left side of the Navy Type COL-20196 Rectifier Power Unit (as viewed from the front) and the Navy Type COL-52291 Radio Transmitter placed on the right side of the Navy Type COL-20196 Rectifier Power Unit. The Navy Type COL-50129 Modulator may be identified by the handset that is mounted in the cabinet door.

When the cabinets have been placed, one on either side of the vertical chassis, fasten the cabinets to the vertical chassis with bolts. (Bolts are supplied in small cloth bags.) Six short bolts and eight long bolts have been provided. Use three short bolts and four long bolts to fasten adjacent cabinet walls and vertical chassis stiffeners together.

3.4. INSTALLATION OF UNITS. The unit assemblies were removed from the cabinets and packed separately for shipment. The unit installation diagram shows the proper location of the units in the cabinets. The following procedure is recommended for the installation of units and components not associated with any particular unit:

IMPORTANT: DO NOT REMOVE SEALS FROM AUTOTUNE COUPLERS UNTIL ALL UNITS HAVE BEEN SECURELY BOLTED IN POSITION.

(a) Install the ventilating blower in the modulator cabinet base by placing the blower unit over the mounting bolts, tightening the nuts that fasten the blower mounting base to the shock mounts, and fastening the canvas bellows to air vent in the base of the cabinet. Connect the blue and red wires to the motor input terminals on strip E302.

(b) Fasten the modulation transformer, T309, to the base of the modulator bay cabinet just in front of the ventilating blower. The transformer terminals are numbered. Connect the large black leads to the terminals. (Two leads should be connected to terminal #4.)

(c) Install the meter panels in the modulator and radio transmitter bays. Fasten each panel in position with the mounting screws. (The panel that contains the AUDIO LEVEL, PLATE VOLTAGE, MOD. PLATE CURRENT and LINE AND FILAMENT VOLTAGE meters belongs in the modulator cabinet.) Connect the leads to the meter terminals. (Wires and meter terminals that are to be connected together have been marked with like numbered tags.)

(d) Connect the wires that are contained in the inter-bay cables to the terminal strips on the Navy Type COL-20196 Rectifier Power Unit, Units J and L. The numbers on the tags on the wires refer to the terminal numbers on the two strips. Connect like numbered wires and terminals.

(e) Connect the large black leads to the large terminals, numbered 28, 29, 30 and 31.

(f) Fasten the transmitter power switch, S211, to the mounting bracket on the front of the Navy Type COL-20196 Rectifier Power Unit and connect the wires to the switch terminals.

(g) Insert the resistors into the clips on the rear of the vertical chassis. Use the item numbers stamped on the resistors and chassis to find the proper positions for the resistors.

(h) Fasten filter capacitor C166 and C167 to the base of the Navy Type COL-52291 Radio Transmitter cabinet.

(i) Connect leads to capacitors C166 and C167 in the radio-transmitter bay.

(j) Fasten the Autotune motor to the bracket on the lower left side of the radio transmitter bay cabinet.

(k) Slide the Filament Supply Unit into position below the Modulator and Driver Unit in the modulator cabinet.

(l) Slide the Speech Amplifier Unit into position in front of the Modulator and Driver Unit.

(m) Insert the handset (HS301) connector plug, P305, into plug receptacle J312 beneath the front edge of the Speech Amplifier Unit chassis.

(n) Place the Output Network Unit on the brackets that are just above the Power Am-

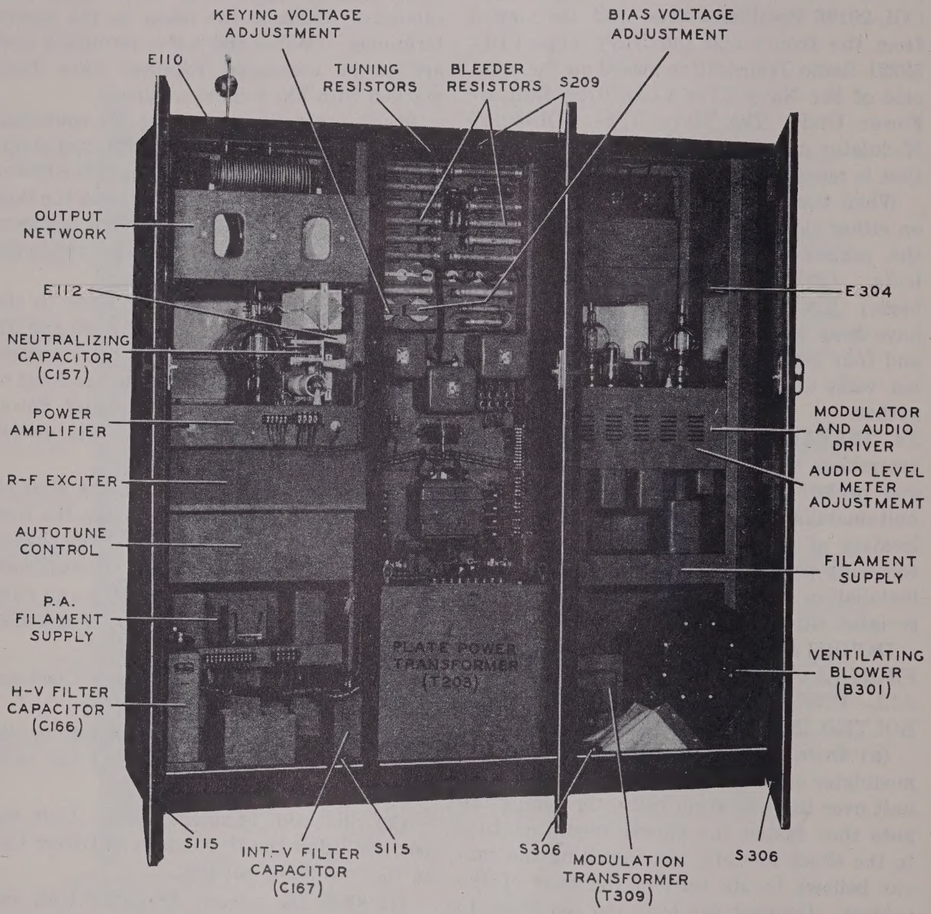

KEYING VOLTAGE ADJUSTMENT
BIAS VOLTAGE ADJUSTMENT
E110
TUNING RESISTORS
BLEEDER RESISTORS
S209
OUTPUT NETWORK
E112
NEUTRALIZING CAPACITOR (C157)
POWER AMPLIFIER
R-F EXCITER
AUTOTUNE CONTROL
P.A. FILAMENT SUPPLY
H-V FILTER CAPACITOR (C166)
PLATE POWER TRANSFORMER (T203)
E304
MODULATOR AND AUDIO DRIVER
AUDIO LEVEL METER ADJUSTMEMT
FILAMENT SUPPLY
VENTILATING BLOWER (B301)
S115
INT-V FILTER CAPACITOR (C167)
S115
S306
MODULATION TRANSFORMER (T309)
S306

Fig. 21 Transmitter, Power Rectifier and Modulator Units (Photo No. 8708)

plifier Unit. (**Note:** The Output Network Unit should be inserted in the cabinet from the rear.)

(o) Fasten the neutralizing capacitor, C157, to the large insulating standoffs in the radio transmitter cabinet. (Large aluminum disks.)

IMPORTANT: Be extremely careful when installing the neutralizing capacitor. Do not change the adjustment of the aluminum disks. If either disk is displaced from the position in which it was locked at the factory, it will be necessary to neutralize the power amplifier stage before placing the transmitter in operation.

(p) Using the copper tubing that is provided, connect the neutralizing capacitor (C157) to the center tap of the power amplifier plate leads. (Junction of L103 and L122.)

(q) Connect the high voltage lead from the PWR. AMP. PLATE CURRENT meter to capacitor C154 near the front of the unit.

(r) Connect the ground terminal (on roof of cabinet) to one of the capacitor C154 mounting bolts with the copper tubing connector.

(s) Connect the antenna terminal to the stator of variable capacitor C159. (The ANTENNA TUNING capacitor.)

(t) Slide the Power Amplifier Filament Supply Unit into position in the lower section of the radio transmitter cabinet.

(u) Connect like numbered leads and terminals on the strips on the rear of the filament supply.

(v) Place the R-F Exciter Unit in the radio transmitter cabinet and fasten the chassis to the mounting brackets with bolts. (**Note:** It is necessary to put the bolts in the exciter chassis because when the Autotune Control Unit is in place it is impossible to insert the bolts.)

(w) Slide the Autotune Control Unit into position beneath the R-F Exciter Unit.

(x) Place the Power Amplifier Unit on the brackets just above the exciter unit.

(y) Connect the intermediate amplifier plate voltage lead (large black lead) to terminal 11; the terminal on the left rear edge of the Power Amplifier Unit chassis.

(z) Connect the power amplifier grid voltage lead (large black lead) to terminal 10; the terminal on the right rear edge of the Power Amplifier Unit chassis.

(aa) Connect the leads to terminal strips E103 and E108. (Like numbered leads and terminals together.)

(ab) Screw the antenna ammeter into position on the ANTENNA terminal.

WHEN PLACING THE DRIVE SHAFTS BETWEEN THE AUTOTUNE UNITS EXTREME CARE SHOULD BE EXERCISED TO PREVENT DISPLACEMENT OF THE TAKE-OFF COUPLERS FROM THE POSITIONS AS LOCKED FOR SHIPMENT. The above matter is extremely important due to the fact that the Autotune assemblies must be mechanically in phase if the tuning elements are to position properly. Due to the fact that the controlling circuit-seeking tap switch is located in the R-F Exciter Unit, the drive shafts between the Autotune motor and the Autotune assembly in the R-F Exciter Unit may be inserted in any position but the drive shafts between the R-F Exciter Unit and the Power Amplifier Unit and between Power Amplifier Unit and the Output Network Unit must be properly placed in order to obtain correct phasing of the Autotune assemblies. When the transmitter was prepared for shipment, take-off couplers were tied solidly in position and the coupling shaft may be inserted as the couplers are lined up when received. A detailed outline of the procedure necessary for the proper alignment of the Autotune assemblies is given in the MAINTENANCE Section of this Instruction Book.

(ac) Remove the seals from the Autotune drive shaft connectors and CAREFULLY insert the drive shafts and tighten the couplers.

IMPORTANT: EACH UNIT MUST BE SECURELY BOLTED IN PLACE TO PREVENT MISALIGNMENT AND BINDING OF THE AUTOTUNE DRIVE SHAFTS, TO ASSURE POSITIVE CONTACT BETWEEN THE CONNECTOR PLUG RECEPTACLES MOUNTED WITHIN THE CABINET AND THE CONNECTOR PLUGS MOUNTED ON THE VARIOUS UNITS, AND TO KEEP ALL PARTS OF THE CHASSIS AT THE SAME POTENTIAL AS THE CABINET.

The order of designation of the inter-unit cables, which applies only to the cabling schematic is as follows: When the wire terminates at a single numbered terminal on a unit or terminal board, the wire route is from the source to the terminal on a specified unit and is indicated by the unit letter designation followed by the terminal number. Thus, if a wire beginning at terminal No. 1 on Unit A is to be connected to terminal No. 1 on Unit B, an arrow at terminal No. 1 on Unit A would indicate B1 and a similar arrow at terminal No. 1 on Unit B would indicate A1.

On cabling and wiring diagrams, the size of wire and type of wire employed in inter-unit cabling is indicated by means of a letter. This is followed by one or more numerals to show the color code. The numerals used conform to the RMA Color Code system given here for reference.

0—Black
1—Brown
2—Red
3—Orange
4—Yellow
5—Green
6—Blue
7—Violet
8—Slate
9—White

For example, a No. 18 stranded type of wire with 500 volt insulation having a white body with a red tracer would be designated "A92."

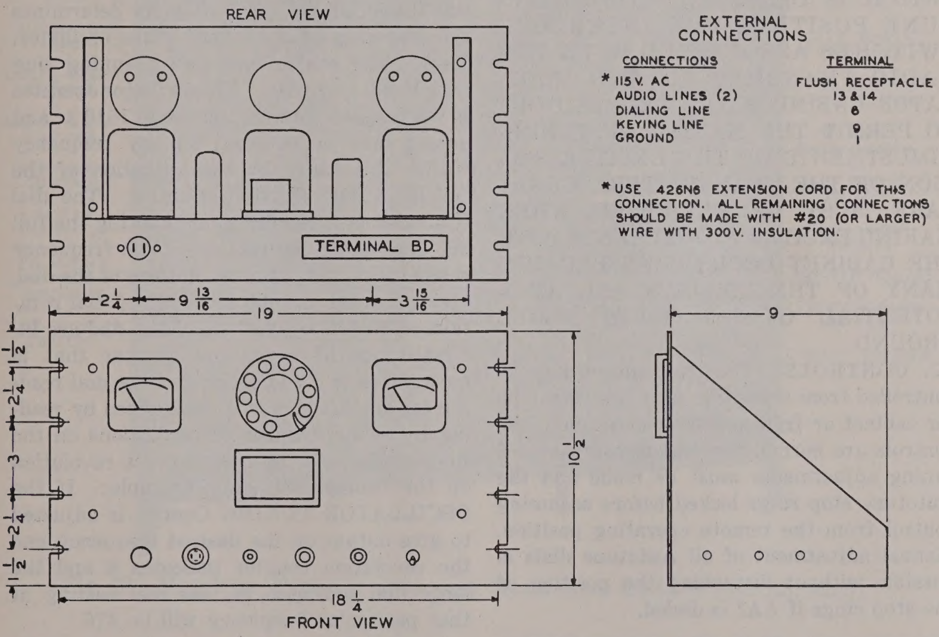
A table showing the Standard Cable Wire Code may be found in the DATA Section of this book.

3.5. **FUSES.** All fuses should be examined and the ratings checked against the Parts List or the table given below. It is good practice to insert each fuse as required during the initial adjustment procedure in order that any faults which may be due to errors in connections to terminals or unintentional grounding of terminals may be quickly determined and also to check and clear each individual circuit in the proper sequence. The fuses used in this equipment, together with the symbol designation of the fuse and the unit in which the fuse is located, are tabulated below:

Symbol Designation	Rating Amps.	Circuit	Unit
F101	⅜ amp*	MO Compartment Heater	R-F Exciter
F102	¼ amp*	Exciter Filament Pri.	R-F Exciter
F103	¾ amp*	Int. Amp. Filament Pri.	R-F Exciter
F104	8 amp	Autotune Motor	P.A. Fil. Supply
F105	8 amp	Autotune Motor	P.A. Fil. Supply
F106	8 amp	Autotune Motor	P.A. Fil. Supply
F107	2 amp	P.A. Filament Pri.	P.A. Fil. Supply
F108	2 amp	P.A. Filament Pri.	P.A. Fil. Supply
F109	¼ amp*	Stabilizer Fil. Pri.	Power Amplifier
F201	3 amp	H.V. Rectifier Filament Pri.	Power
F202	3 amp	H.V. Rectifier Filament Pri.	Power
F203	2 amp	Relay Rectifier Supply Pri.	Power
F204	3 amp	L.V. Rectifier Plate Pri.	Power
F205	3 amp	Bias Rect. Plate Pri.	Power

Symbol Designation	Rating Amps.	Circuit	Unit
F206	1 amp	L.V. Rectifier Fil. Pri.	Power
F207	1 amp	Bias Rectifier Fil. Pri.	Power
F208	3 amp	Relay Supply Output	Power
F301	1 amp*	Modulator Fil. Pri.	Fil. Supply
F302	⅜ amp*	Speech Amp. Fil. Pri.	Fil. Supply
F303	⅜ amp*	Audio Driver Fil. Pri.	Mod. & Audio Driver
F304	2 amp	Mod. Plate Supply	Base Components
F401	¼ amp*	Remote Unit Power Input	Remote Control

* Slo-Blo Type. Do not replace a Slo-Blo fuse with a fuse of the quick acting type.



EXTERNAL CONNECTIONS

CONNECTIONS	TERMINAL
* 115 V. AC	FLUSH RECEPTACLE
AUDIO LINES (2)	13 & 14
DIALING LINE	8
KEYING LINE	9
GROUND	1

* USE 426N6 EXTENSION CORD FOR THIS CONNECTION. ALL REMAINING CONNECTIONS SHOULD BE MADE WITH #20 (OR LARGER) WIRE WITH 300V. INSULATION.

Fig. 22 Remote Control Unit Installation (Dwg. No. 2168A)

3.6. **REMOTE UNIT.** The remote control unit is designed for relay rack mounting. The unit will fit the standard 19 inch relay rack. Refer to Fig. 22. All connections to the unit are made to a terminal strip and plug on the rear of the chassis.

4.1. WARNING. OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. SEE PAGES 9 AND 10. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE EQUIPMENT WITH THE HIGH VOLTAGE SUPPLY TURNED ON. DO NOT DEPEND UPON DOOR SWITCHES OR INTERLOCKS FOR PROTECTION BUT ALWAYS OPEN THE MAIN SWITCH IN THE SUPPLY LINE TO THE EQUIPMENT. BOTH THE FRONT AND REAR DOORS OF THE TRANSMITTER CABINETS ARE PROVIDED WITH INTERLOCK SWITCHES. WHEN THE L.V.-TUNE-OPERATE SWITCH IS OPERATED TO THE L.V.-TUNE POSITION, THE INTERLOCK SWITCHES ASSOCIATED WITH THE RADIO TRANSMITTER AND MODULATOR CABINETS ARE SHORTED OUT TO PERMIT THE MAKING OF TUNING ADJUSTMENTS OF THE EXCITER SECTION OF THE TRANSMITTER. GREAT CARE MUST BE EXERCISED WHEN MAKING EXCITER ADJUSTMENTS WITH THE CABINET DOORS OPEN BECAUSE MANY OF THE CIRCUITS ARE AT A POTENTIAL OF 500 VOLTS ABOVE GROUND.

4.2. CONTROLS. The transmitter may be controlled from a position near the transmitter cabinet or from a remote position. The controls are normal for remote control. All tuning adjustments must be made and the Autotune stop rings locked before assuming control from the remote operating position. Manual adjustment of all Autotune dials is possible without disturbing the position of the stop rings if AA2 is dialed.

IMPORTANT: IT IS OF UTMOST IMPORTANCE THAT AFTER THE SELECTING OF A FREQUENCY CHANNEL AND IF THE SINGLETURN DIALS COME TO REST IN A POSITION SUCH THAT THE INDICATOR MARK IS OPPOSITE THE BLANK SPACE ON THE TUNING KNOB, THAT THE DIALS BE ROTATED IN A COUNTERCLOCKWISE DIRECTION TO MAKE TUNING ADJUSTMENTS. **FINAL ADJUSTMENT OF ALL CONTROLS SHOULD BE MADE BY ROTATING THE CONTROLS IN A CLOCKWISE DIRECTION.** IF AN ATTEMPT IS MADE TO ROTATE THE TUNING DIALS IN A CLOCKWISE DIRECTION THE DIALS MAY BE LOOSENED ON THE SHAFTS BECAUSE THE SINGLETURN UNIT HOME STOP PAWL PREVENTS THE ROTATION OF THE SHAFT THROUGH MORE THAN 360 DEGREES.

The following paragraphs list the Control designations and give the elements controlled by each:

a. OSCILLATOR TUNING Control. The OSCILLATOR TUNING Control determines the frequency of the output of the oscillator, V101. The control operates a tuning slug within inductor L104. The oscillator operates in the frequency range 1000 kc to 1510 kc and output may be obtained on any frequency within this range by the operation of the OSCILLATOR TUNING Control. The dial is divided into 100 divisions covering the full 360 degrees of dial rotation. The frequency range is covered in ten revolutions of the dial, giving a total of 1000 divisions of dial rotation. The full revolutions of the dial are indicated on the revolution counter that is mounted near the large control. A dial reading for any frequency is determined by reading the whole number of revolutions on the counter dial and the fraction of a revolution on the tuning dial. For example: If the OSCILLATOR TUNING Control is adjusted to give output on the desired frequency and the revolution counter indicates 4 and the large dial indicates 76, the dial setting at that particular frequency will be 476.

b. EXCITER BAND SWITCH. The EXCITER BAND SWITCH operates switches S102, S103 and S104. Switch sections S102A and S102B connect the proper inductor in the plate circuit of the frequency multiplier, V103. Switch section S102C controls the screen voltage that is applied to the R-F

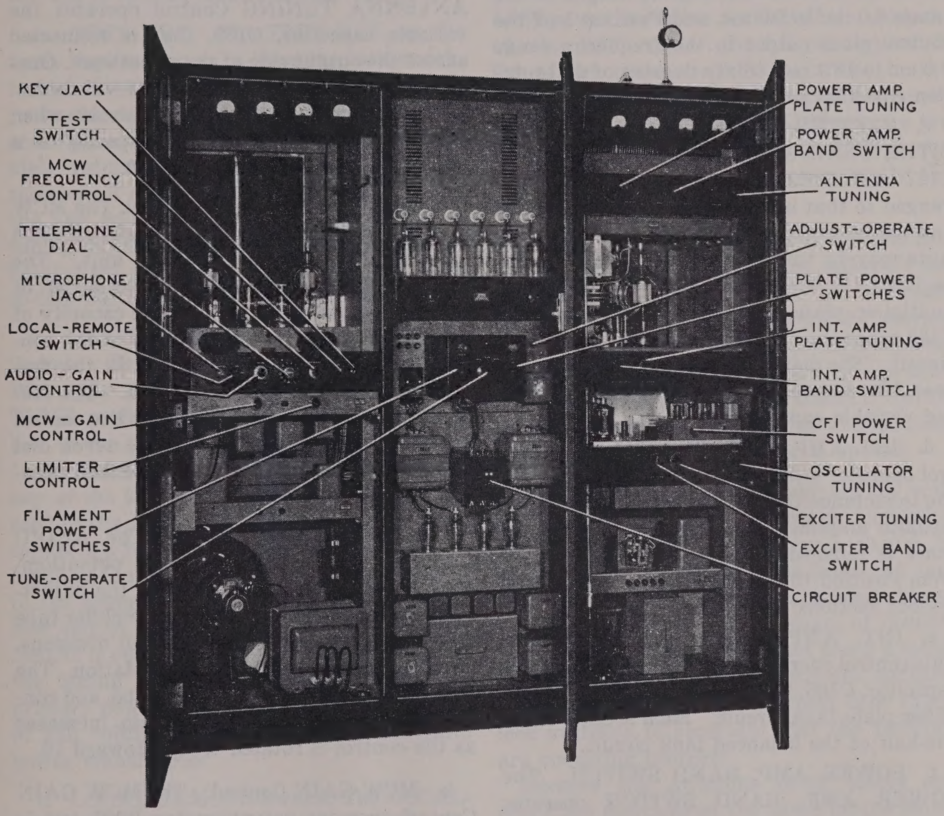


Fig. 23 Modulator, Power Rectifier and Transmitter Units (Photo No. 8709)

Amplifier-Tripler, V104. Switch sections S103A, S103B, S103C and S104A connect the proper inductor in the R-F Amplifier-tripler plate circuit. The dial is divided into four divisions. Position 4 of the EXCITER BAND SWITCH selects the proper inductors to give output in the frequency range 2.0 mc to 3.0 mc, Position 3 gives output in the range 3.0 mc to 6.0 mc, Position 2 gives output in the range 6.0 mc to 9.0 mc, and Position 1 of the control gives output in the frequency range 9.0 mc to 18.1 mc. Sixty degrees of dial rotation cover all four switch positions.

c. EXCITER TUNING Control. The EXCITER TUNING Control operates capacitors C127 and C132. The two capacitors are ganged so that both the frequency multiplier and the intermediate amplifier plate tank circuits may be tuned by a single control. Capacitor C127 is associated with the frequency multiplier plate tank circuit and capacitor C132 tunes the r-f amplifier-tripler plate tank circuit. The dial is divided into 100 divisions over 180 degrees to cover the full range of the variable capacitors.

d. INT. AMP. BAND SWITCH. This control operates switches S112 and S116 to vary the inductance that is connected in the intermediate amplifier plate circuit. The inductance is reduced, as the control is operated from Position 10 toward Position 1, by shorting-out sections of inductor L128.

e. INT. AMP. PLATE Tuning Control. This control operates the dual section variable capacitor, C105, to tune the intermediate amplifier plate tank circuit. Each section tunes one-half of the balanced tank circuit.

f. POWER AMP. BAND SWITCH. The POWER AMP. BAND SWITCH operates switch S111 in the Output Network Unit. The switch is of the shorting type and shorts out sections of inductor L125 as the switch is operated. The dial is divided into 10 divisions. Maximum inductance is in the circuit when the POWER AMP. BAND SWITCH is in Position 10.

g. POWER AMP. TUNING Control. The POWER AMP. TUNING Control operates the variable capacitor C158. Capacitor C158 is connected across the input side of the pi network which is used as a combination plate tank and antenna coupling. The dial is divided into 100 divisions, covering 180 degrees of the dial rotation. The 180 degrees of rotation permit the variation of the capacity from a minimum at 0 to a maximum at 100.

h. ANTENNA TUNING Control. The ANTENNA TUNING Control operates the variable capacitor, C159, that is connected across the output side of the pi network. One-half of the dial is divided into 100 divisions. The minimum capacity is in the circuit when the dial indicates 0 and the capacity is a maximum at a dial setting of 100.

i. MCW FREQUENCY Control. The MCW FREQUENCY Control operates switch S304 located in the speech amplifier unit. The switch changes the frequency of the output of the tone oscillator by varying the capacity of the tank circuit. Seven positions of the control are available, giving output in the frequency range 400 cps to 1200 cps. The frequency of the output increases as the control is rotated from 1 toward 7. The seven dial divisions cover 280 degrees of control rotation.

j. AUDIO GAIN Control. The AUDIO GAIN Control operates the dual potentiometer, R324. The control permits the adjusting of the input to the 1st audio amplifier tube V301. The dial is divided into 10 divisions, covering 280 degrees of control rotation. The input to the 1st audio amplifier tube, and consequently the speech amplifier gain, increases as the control is rotated from 0 toward 10.

k. MCW GAIN Control. The MCW GAIN Control operates potentiometer R325 and is located on the speech amplifier chassis. The control is accessible if the front door of the modulator cabinet is opened. The control regulates the output of the tone oscillator V305. The dial is divided into 10 divisions, covering 280 degrees of rotation. The gain of V305 increases as the control is rotated from 0 toward 10.

l. LIMITER GAIN Control. The LIMITER

GAIN Control operates potentiometer R326. The potentiometer permits the adjusting of the voltage that is applied to the plates of the limiter rectifier tube, V306. (Refer to Section II of this book for details of the operation of the limiter circuits.) The dial is divided into 10 divisions, covering 280 degrees of rotation. The limiting effect increases as the dial is rotated from 0 toward 10.

m. TEST KEY. The TEST KEY, as the name implies, serves to close the carrier control circuit during the time that tuning adjustments are being made. If the switch is operated in one direction the key will immediately return to the normal position when released; if operated in the opposite direction the key will lock to permit the making of tuning adjustments without the necessity of holding the telegraph key closed or the push-to-talk button on the microphone operated.

n. L.V. TUNE - H.V. TUNE - OPERATE Switch. This control operates switch S206. When the control is operated to the L.V. TUNE position the circuit from the power line to the plate power contactors is broken to prevent the application of high voltage to any of the transmitter circuits. When operated to the H.V. TUNE position switch S206 connects a resistor in series with each power input lead to reduce the voltage that is applied to the primary of the high voltage transformer and to give poor regulation. When the control is operated to the OPERATE position the tuning resistors are removed from the primary power leads to permit the application of full voltage to the primary of the plate power transformer.

o. LOCAL-REMOTE Switch. The LOCAL-REMOTE Control operates switch S303. The switch is normal in the REMOTE position. When operated in one direction the switch is non-locking and will return to the REMOTE position as soon as released, but when operated in the opposite direction the switch locks for LOCAL control of the transmitter.

p. Power Level Switch. The power level switch, S205, is located on the vertical chassis inside the cabinet door of the power bay. If operated to the HIGH position output up to 5 KW of r-f power may be obtained with CW emission. The switch operates relay K202 when operated to the LOW position and relay K203 when operated to the HIGH position if CW emission is selected. Selecting either MCW or VOICE emission breaks the circuit necessary for the operation of relay K203 and gives r-f power output of up to 3 kw. When LOW power operation is selected the contacts of relay K202 connect the full primary winding of the plate power transformer in the circuit. When HIGH power operation is selected the contacts of relay K203 select a tap on the primary of transformer T203 to increase the turns-ratio and consequently the output voltage.

q. ADJUST-OPERATE Switch. When this switch, S210, is operated to the ADJUST position the interlock switches in the radio transmitter and modulator bays are shorted out to permit the adjustment of the low power transmitter stages with the doors of the cabinets open. The ADJUST-OPERATE Switch is located on the vertical chassis and is accessible if the cabinet front door is opened.

4.3. INSPECTION. Before applying any voltage to the transmitter a thorough inspection of all connections and terminals should be made. **The rectifier tube plate leads and caps should be checked for clearance to metal objects.** The leads should be tied by means of insulating cord so that the caps do not touch a metal object or come in contact with one another. Inspect the rear panel and front door interlock switches to ascertain that the switches are operating properly.

Remove the Autotune cover plates and check the positions of the pawls on the Autotune units. The corresponding pawls should be operated on all units. If the two singleturn units and the multiturn unit located on the R-F Exciter Unit are properly synchronized, that is, corresponding pawls are operated or may be operated by less than one-half revolution of the drive shaft, and the singleturn units located on the Power Amplifier Unit and the Output Network Unit are synchronized with each other but are not synchronized with the units located in the R-F Exciter Unit, the short coupling drive shaft between the Autotune assemblies should be removed and the drive shafts rotated manually in a clockwise direction until corresponding pawls on all of the Autotune units are operated. (Refer to the MAINTENANCE Section of this book for a detailed outline of the alignment procedure.)

4.4. CIRCUIT TESTS. Before any of the tubes are inserted in the units it is recommended that the control circuits be checked. The circuits should be cleared one at a time by removing all of the fuses from the receptacles and inserting each as needed to proceed with the operation of the transmitter controls. When replacing the fuses care should be exercised to place the proper fuse in the receptacle. The table below lists the item numbers and ratings of the fuses used in the equipment:

Item Number	Circuit	Rating
F101	M.O. Heater	3/8 amp*
F102	Exciter Filament Pri.	1/4 amp*
F103	Int. Amp. Filament Pri.	3/4 amp*
F104	Autotune Motor	8 amp
F105	Autotune Motor	8 amp
F106	Autotune Motor	8 amp
F107	P.A. Filament Primary	2 amp
F108	P.A. Filament Primary	2 amp
F109	Stabilizer Filament Pri.	1/4 amp*
F201	H.V. Rectifier Filament Pri.	3 amp
F202	H.V. Rectifier Filament Pri.	3 amp
F203	Relay Rectifier Supply Pri.	2 amp
F204	L.V. Rectifier Plate Primary	3 amp
F205	Bias Rectifier Plate Primary	3 amp
F206	L.V. Rectifier Filament Pri.	1 amp
F207	Bias Rectifier Filament Pri.	1 amp
F208	Relay Supply Output	3 amp
F301	Modulator Filament Pri.	1 amp
F302	Speech Amp. Filament Pri.	3/8 amp*
F303	Audio Driver Filament Pri.	3/8 amp*
F304	Modulator Plate Supply	2 amp
F401	Remote Control Unit	1/4 amp*

* Slo-Blo fuse. Quick acting fuses should not be replaced with fuses of the Slo-Blo type.

When all of the fuses have been removed from the equipment the procedure outlined below should be followed to check the operation of the control and power circuits:

(a) Insert the LINE AND FIL. VOLTAGE meter cord plug into the cord plug receptacle designated as LINE (located in wall of Navy Type COL-50129 Modulator Unit Cabinet.)

(b) Operate the circuit breaker, S211, to the ON position and observe the reading on the LINE AND FIL. VOLTAGE meter. (Refer to 4.5. **VOLTAGE ADJUSTMENT** if the meter indicates above or below **230 volts.**)

(c) Open the front door of the Navy Type COL-20196 Rectifier Power Unit Cabinet and insert fuse F203 into the **48 V. PRI.** fuse receptacle.

(d) Insert fuse F208 into the **48 V. D.C.** fuse receptacle.

(e) Open the front door of the Navy Type COL-52291 Radio Transmitter and insert AUTOTUNE MOTOR fuses F104, F105 and F106 (1, 2, and 3).

(f) With the circuit breaker in the ON position, press the FILAMENT START Switch and dial a frequency channel. If the motor operates, continue the circuit check. If the motor fails to operate, check all fuses that have thus far been inserted. If the fuses are all in good condition, look for loose connections.

If the motor starts but immediately stops or the motor starts to rotate in the wrong direction (correct direction of rotation is indicated by all controls rotating in a counterclockwise direction when the motor starts), the power phasing is incorrect. Correct this condition by interchanging any two of the leads from the power source.

(g) When the above circuits are operating satisfactorily insert the **EXCITER FIL.** fuse, F102, into the receptacle on top of the R-F Exciter Unit Chassis.

(h) Insert the extension cord plug into the FIL. EXT. position of receptacle J303.

(i) Insert the plug that is on the opposite end of the extension cord into the plug receptacle designated as **6.3 EXCITER FIL.** (Located on the R-F Exciter Unit Chassis.)

IMPORTANT: WITH THE TUBES REMOVED FROM THE SOCKETS AND THEREFORE NO LOAD ON THE SECONDARY OF THE FILAMENT TRANSFORMERS, THE VOLTAGES THAT ARE INDICATED ON THE FILAMENT VOLTMETER MAY VARY CONSIDERABLY FROM THE CORRECT VALUE BUT NO TRANSFORMER TAP ADJUSTMENTS SHOULD BE MADE UNTIL THE TUBES HAVE BEEN PLACED IN THE SOCKETS AND THE VOLTAGE CHECKED.

(j) If a reading is indicated on the voltmeter insert the 813 FIL. fuse, F103.

(k) Insert the metering cord plug into the 10 V. 813 FIL. plug receptacle. A voltage reading indicates proper operation of the circuit.

(l) Insert PWR. AMP. FIL. FRONT fuse, F107.

(m) Insert the metering cord plug into the 7.5 VOLT FIL. plug receptacle near the front Type 750TL tube and check the voltmeter reading.

(n) Insert the PWR. AMP. FIL. REAR fuse, F108, and insert the metering cord plug into the 7.5 VOLT FIL. plug receptacle that is near the rear Type 750TL tube. Check the voltmeter reading.

(o) Insert the 811 FIL. fuse, F109, into the receptacle on the Power Amplifier Unit Chassis.

(p) Insert the metering cord plug into the 6.3 VOLT FIL. plug receptacle (located near the Type 811 tube) and check for an indication of voltage on the voltmeter.

(q) Open the front door of the Navy Type COL-20196 Rectifier Power Unit Cabinet and insert the BIAS FIL. fuse, F207.

(r) Insert the metering cord plug into the BIAS FIL. 2.5 V. plug receptacle and check the meter reading.

(s) Insert the L.V. FIL. fuse, F206.

(t) Insert the metering cord plug into the L.V. FIL. 2.5 V. plug receptacle and check the voltmeter reading.

(u) Insert the H.V. FIL. fuses, F201 and F202, and check the circuits by inserting the metering cord plug into the H.V. RECT. FIL. 1 and H.V. RECT. FIL. 2 plug receptacle.

(v) Returning to the Navy Type COL-50129 Modulator Bay, insert the SP. AMP. FIL. fuse, F302, and insert the metering plug into the unmarked plug receptacle on the front of the Speech Amplifier Unit Chassis. Check the voltmeter for an indication of voltage.

(w) Insert the MOD. FIL. fuse, F301, and check the operation of the circuit by inserting the metering cord plug into 7.5 VOLTS plug receptacle on the Modulator and Audio Driver Unit Chassis.

(x) Insert the DRIVER FIL. fuse, F303, and check the operation of the audio driver filament circuit by inserting the metering cord plug into the 10 VOLTS plug receptacle.

(y) Return to the Navy Type COL-20196 Rectifier Power Unit and insert the BIAS PLATE fuse, F205.

(z) With the TUNE-OPERATE switch in the L.V. TUNE position, press the PLATE START switch. If the PLATE pilot lamp glows the bias supply is operating satisfactorily.

(aa) Press the PLATE STOP switch and insert the L.V. PLATE fuse, F204, into the fuse receptacle.

(ab) Dial an Autotune channel.

(ac) Press the PLATE START switch and check the reading on the CHANNEL INDICATOR meter on the Remote Control Unit. (The meter is operated by voltage supplied by the L-V Power Supply and therefore if the Channel Indicator operates the L-V Power Supply circuits are operating satisfactorily.)

(ad) Return to the Navy Type COL-52291 Radio Transmitter Bay and insert the M.O. HEATER fuse. (Located on top of the R-F Exciter Unit Chassis.)

(ae) Insert the modulator circuit primary fuse, F304, into the clips near the base of the Navy Type COL-50129 Modulator Unit Cabinet.

4.5. VOLTAGE ADJUSTMENT. When the procedure outlined under **4.4. CIRCUIT TESTS** has been completed and the circuits have been found to be operating satisfactorily, the transmitter circuit breaker, S211, should be operated to the OFF position and the tubes inserted into the sockets. (Refer to **1.1.2. Tube Complement** in Section I of this Instruction Book.)

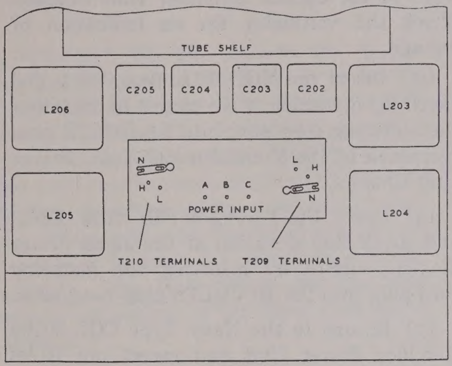


Fig. 24 Autotransformer Connections
(Dwg. No. 500 4556 00A)

All filament transformers have tapped primaries so that the turns-ratio may be adjusted to give the correct voltage for application to the filaments of the tubes with a supply voltage of 210, 220, 230, 240, or 250 volts. The taps have been adjusted at the factory for a voltage of 230 volts. If the voltage as indicated by the LINE AND FIL. VOLTAGE meter, is too low or too high by 10 volts, that is, the meter indicates 220 volts or 240 volts, the taps on autotransformers T209 and T210 may be used to correct the input voltage. If the meter indicates voltage closer to 220 volts than to 230 volts, remove the cover plate from the autotransformer terminals located near the front bottom edge of the vertical chassis in the Navy Type COL-20196 Power Rectifier Unit, and with the circuit breaker S211 in the OFF position change the jumpers from terminals **N** to terminal **L.** If the meter indicates voltage near 240 volts change the jumpers to terminals **H.** Further adjustments of filament voltages may be made by changing the taps on the individual filament transformers.

Filament voltages on the tubes in the transmitter unit may be measured using the LINE AND FIL. VOLTAGE meter and the extension cord that is provided. No provision has been made for the metering of filament voltages in Remote Control Unit. The control unit is designed to operate from a 115 volt a-c source and the single power transformer, T403, has a tapped primary so that the filament voltage may be kept constant by changing the taps if the supply voltage varies from the normal value.

WARNING: WHEN MEASURING THE FILAMENT VOLTAGES OF THE RECTIFIER TUBES THE PLATE VOLTAGE SHOULD BE TURNED OFF. THE CENTER TAP OF THE FILAMENT TRANSFORMER IS AT THE FULL POTENTIAL OF THE SUPPLY ABOVE GROUND.

The following list has been compiled to aid the operating personnel in checking voltages and making filament transformer adjustments:

FILAMENT VOLTAGE CHART

Tube Symbol	Tube Type	Unit	Filament Transformer	Correct Voltage	Plug Receptacle
V101	6A8	R-F Exciter	T103	6.3	J104
V102	6AG7	R-F Exciter	T103	6.3	J104
V103	807	R-F Exciter	T103	6.3	J104
V104	807	R-F Exciter	T103	6.3	J104
V105	813	R-F Exciter	T102	10.0	J104
V106	813	R-F Exciter	T102	10.0	J104

FILAMENT VOLTAGE CHART (Cont.)

Tube Symbol	Tube Type	Unit	Filament Transformer	Correct Voltage	Plug Receptacle
V107	VR-150-30	R-F Exciter	——	——	——
V109	6SJ7	R-F Exciter	T103	6.3	J104
V110	6SL7GT	CFI	T103	6.3	J104
V111	6A8	CFI	T103	6.3	J104
V113	6SN7GT	CFI	T103	6.3	J104
V114	750TL	Power Amplifier	T104	7.5	J110
V115	750TL	Power Amplifier	T105	7.5	J111
V116	811	Power Amplifier	T106	6.3	J122
V201	872A	Power	T201	5.0	J201
V202	872A	Power	T201	5.0	J201
V203	872A	Power	T201	5.0	J201
V204	872A	Power	T202	5.0	J202
V205	872A	Power	T202	5.0	J202
V206	872A	Power	T202	5.0	J202
V207	866/866A	Power	T207	2.5	J203
V208	866/866A	Power	T207	2.5	J203
V209	866/866A	Power	T208	2.5	J204
V210	866/866A	Power	T208	2.5	J204
V301	6SL7GT	Speech Amp.	T308	6.3	J311
V302	6C8G	Speech Amp.	T308	6.3	J311
V303	6C8G	Speech Amp.	T308	6.3	J311
V304	6SJ7	Speech Amp.	T308	6.3	J311
V305	6SN7GT	Speech Amp.	T308	6.3	J311
V306	6X5GT	Speech Amp.	T308	6.3	J311
V307	801	Speech Amp.	T308	7.5	——
V308	801	Speech Amp.	T308	7.5	——
V309	845	Mod. & Driver	T305	10.0	J305
V310	845	Mod. & Driver	T305	10.0	J305
V311	450TL	Mod. & Driver	T307	7.5	J304
V312	450TL	Mod. & Driver	T307	7.5	J304
V401	6SJ7	Remote Control	T403	6.3	——
V402	6SN7GT	Remote Control	T403	6.3	——
V403	6X5GT	Remote Control	T403	6.3	——

The bias and low voltage rectifier plate power transformers also are provided with tapped primaries so that some compensation may be made for variations in source voltage. Before any taps are changed on the transformer primaries, the output of the supplies should be measured under normal load and the voltage checked against the supply voltages given in the MAINTENANCE Section of this book.

4.6. R-F CIRCUIT ADJUSTMENT. The adjustment of eight transmitter controls is necessary to obtain the maximum r-f output upon any particular frequency. Three of the controls, the OSCILLATOR TUNING, EXCITER BAND SWITCH, and EXCITER TUNING Controls are located on the R-F Exciter Unit. Two controls, the INT. AMP. BAND SWITCH and the INT. AMP. PLATE Tuning controls are located on the Power Amplifier Unit. The three remaining controls, the POWER AMP. BAND SWITCH, POWER AMP. TUNING, and ANTENNA TUNING Controls, are located on the Output Network Unit. All eight controls operate in conjunction with the Autotune positioning mechanism. When the controls have been properly adjusted, the Autotune stop rings may be locked in position by operating the locking bars on the front of each dial a fraction of a revolution in a clockwise direction. All six controls may be operated without disturbing the stop rings if Manual tuning is selected by dialing **AA2**. (**Note:** Dialing "A" gives eleven dial pulses, the maximum obtainable with a single operation of the telephone dial.) Channel 11 may be selected by dialing **AA1**.

4.6.1. Oscillator Calibration. The master oscillator is continuously tunable in the frequency range 1000 kc to 1510 kc. A calibration circuit has been incorporated in the transmitter to permit the accurate setting of the output frequency of the oscillator. The standard of frequency is a 200 kc quartz crystal that is connected in the oscillator section of the CFI circuit. By multiplying the frequency of the output of the 200 kc oscillator and beating the r-f output of the master oscillator with the harmonics of 200 kc output, audio beat notes are obtained and are used as "check points" in conjunction with the calibration table that is furnished with each transmitter. The "check points" have been printed in heavy black type in the Calibration Tables. The audible beat notes are used to set the movable indicator mark on the OSCILLATOR TUNING Control. **The frequencies given in the tables are the transmitter output frequencies and not the oscillator output frequency.**

A total of ten revolutions of the multiturn dial (OSCILLATOR TUNING) is necessary to cover the oscillator tuning range. The counter dial indicates the number of full revolutions of the multiturn dial and the fraction of a revolution is indicated by the position of the dial with respect to the indicator mark.

For example: If the Calibration Table indicates that the dial setting for a particular frequency is 864 the multiturn dial should be rotated until the counter dial indicates 8 and the indicator mark is opposite 64 on the large dial.

(a) Interpolation of Dial Settings

Dial settings for frequencies between those given in the table may be obtained by interpolation. The following method should be used to determine the proper setting for the OSCILLATOR TUNING Control:

1. Find the difference between the desired frequency and the next lower frequency that is given in the table.

2. Find the difference between the lower frequency used in Step 1 and the next higher frequency listed in the table.

3. Find the difference between the dial settings listed opposite the frequencies used in Step 2.

4. Multiply the result of Step 3 by the result of Step 1 and divide by the result of Step 2.

5. Add the result of Step 4 to the lowest dial setting used in Step 3.

(b) Calibration

The following procedure is recommended for the setting of the oscillator frequency:

1. Having chosen an operating frequency, refer to the Calibration Table and locate the "check point" that is nearest the chosen frequency in the FREQUENCY column. (Frequencies shown in heavy type in the Calibration Tables.) Dial a channel and when the Autotune mechanism has come to rest, operate the locking bar on the OSCILLATOR TUNING Control in a counterclockwise direction and rotate the control until the revolution counter dial and large dial readings correspond to the setting obtained from the table.

2. Operate the TUNE-OPERATE switch to the L.V. TUNE position.

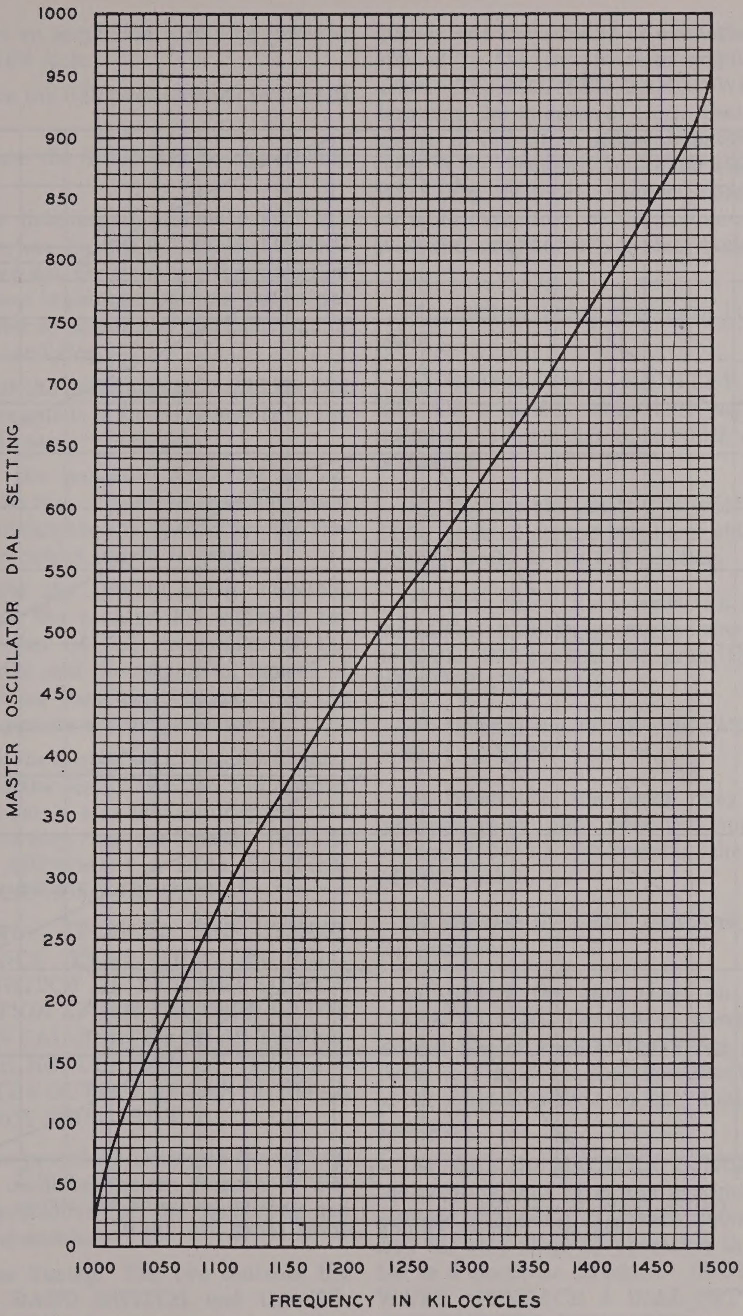


Fig. 25 Master Oscillator Calibration Curve (Dwg. No. 502 0187 003)

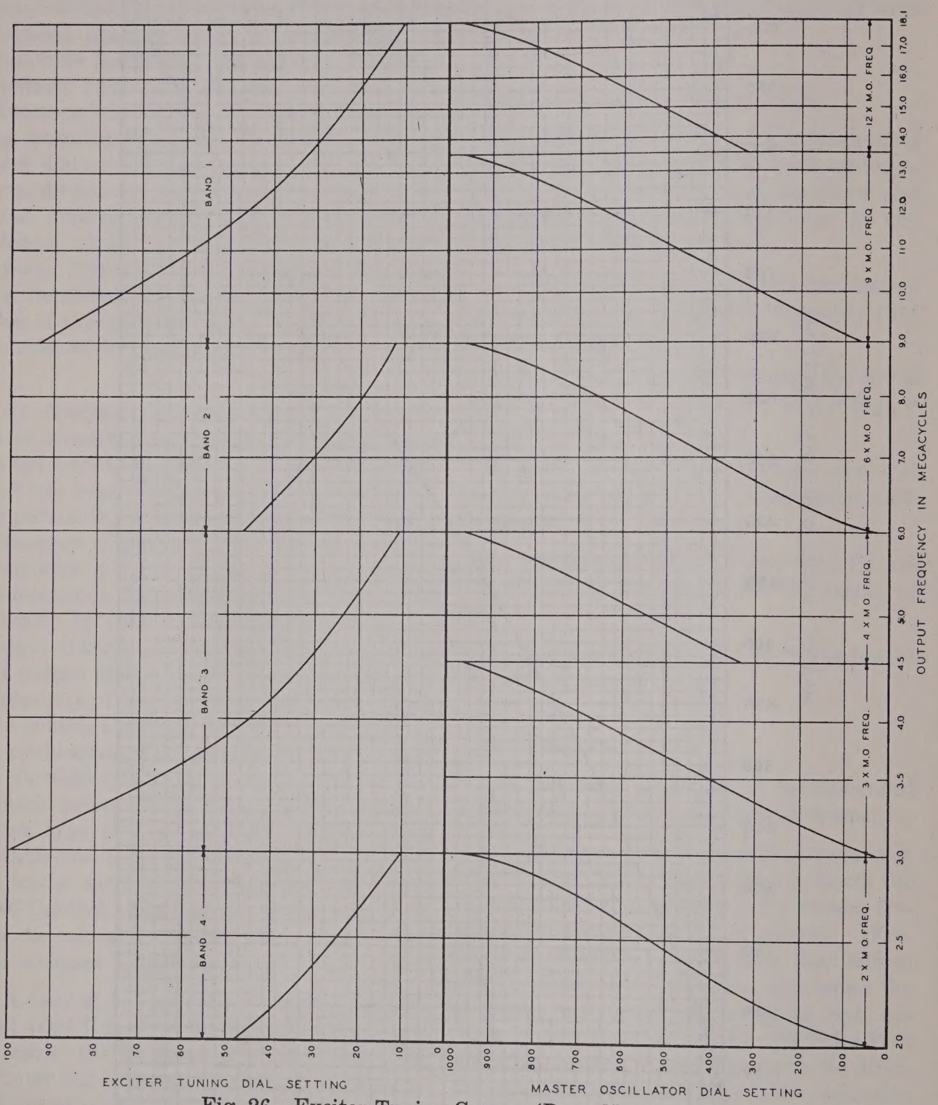


Fig. 26 Exciter Tuning Curves (Dwg. No. 1631C)

3. Insert an earphones cord plug into the CFI PHONES jack.

4. Rotate the CFI power switch to the ON position.

5. Operate the TEST key to the locking position.

6. While listening to the output of the CFI Unit, rotate the OSCILLATOR TUNING Control a few dial divisions in either direction until zero beat is obtained between the output of the master oscillator and the harmonic of the 200 kc oscillator.

7. Adjust the indicator mark until the dial setting corresponds to that obtained from the table for the same "check point."

8. With the indicator mark set as explained under Step 7, refer to the Calibration Table and obtain the dial setting for the frequency upon which output is desired.

9. Operate the OSCILLATOR TUNING Control until the counter dial indicates the correct number of full revolutions of the multiturn dial and the remaining figures of the dial setting that was obtained from the table, are opposite the indicator mark.

10. With the control set as described under Step 9, hold the dial in position and operate the locking-bar in a clockwise direction until the Autotune stop rings are locked. (**NOTE:** ALWAYS APPROACH A DIAL SETTING IN A CLOCKWISE DIRECTION.)

WARNING: IT IS OF THE UTMOST IMPORTANCE THAT THE CFI UNIT POWER SWITCH BE TURNED TO THE OFF POSITION AFTER THE OSCILLATOR HAS BEEN CALIBRATED SO AS TO PREVENT THE MODULATION OF THE CARRIER BY THE OUTPUT OF THE CRYSTAL FREQUENCY INDICATOR.

The above procedure completes the calibration of the oscillator for one frequency. Repeat the procedure for the remaining ten frequency channels.

4.6.2. Exciter Tuning. The two controls, the EXCITER BAND SWITCH and the EXCITER TUNING Controls, control the frequency and the amount of excitation that is applied to the intermediate amplifier tube grids. The EXCITER BAND SWITCH determines the number of times that the frequency of the output of the oscillator is multiplied in the frequency multiplier stages. The EXCITER TUNING Control operates the variable capacitors in the frequency multiplier and amplifier-tripler plate tank circuits.

The exciter tuning procedure is outlined below:

(a) Operate the EXCITER BAND SWITCH to the frequency range position that includes the frequency upon which operation is desired.

(b) Operate the GRID CURRENT switch, S105, (located on top left-hand side of R-F Exciter Unit) to the 813 position.

(c) With the LOCAL-REMOTE switch in the LOCAL position operate the circuit breaker to the ON position and press the FILAMENT START button.

(d) Operate the TUNE-OPERATE switch to the L.V. TUNE position.

(e) When the time delay relay and the interlock relay have operated, apply plate voltage (500 v.) by pressing the PLATE START button.

(f) Operate the TEST switch to the locking position.

(g) Unlock the stop rings on the EXCITER TUNING Control by operating the locking bar in a counterclockwise direction. Refer to Fig. 26 for the approximate setting of the control for the frequency that has been selected.

(h) With the EXCITER TUNING set in the position that gives the maximum intermediate amplifier grid current meter reading, lock the stop rings by operating the locking bar in a clockwise direction. (NOTE: ALWAYS APPROACH A DIAL SETTING IN A CLOCKWISE DIRECTION.)

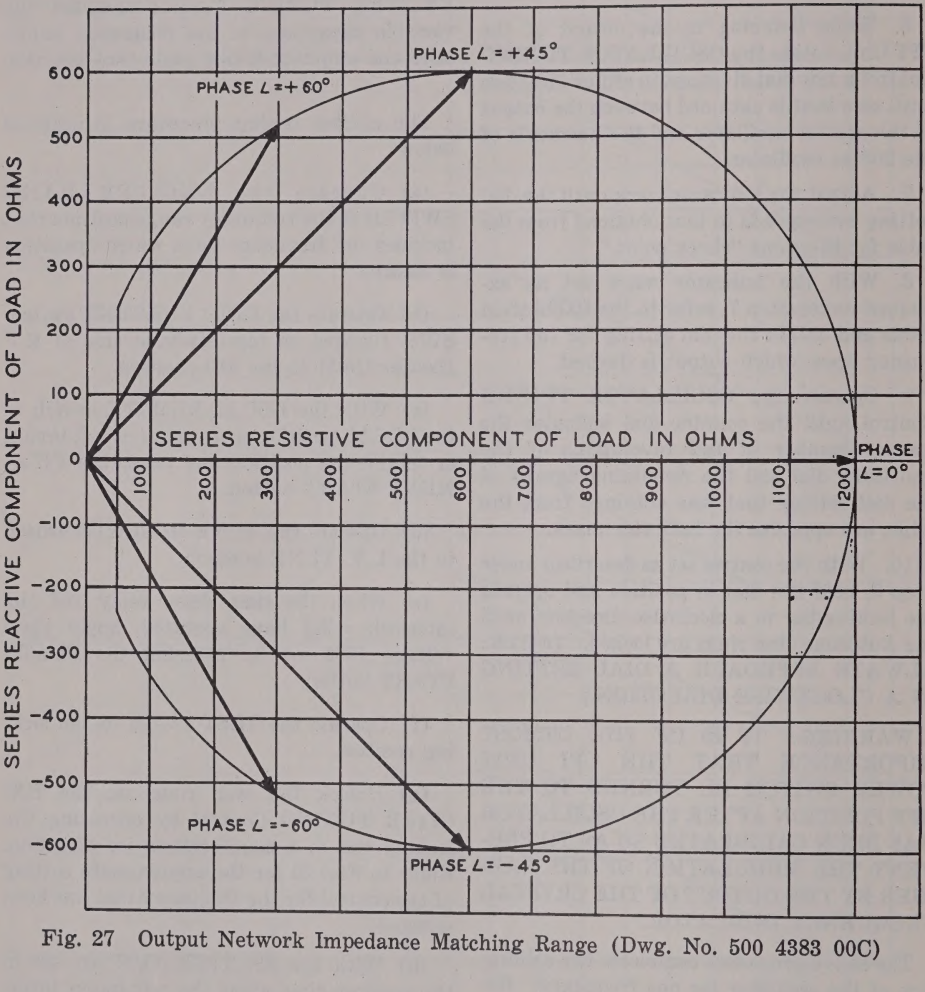


Fig. 27 Output Network Impedance Matching Range (Dwg. No. 500 4383 00C)

(i) Release the TEST switch and press the PLATE STOP button.

The above procedure completes the tuning of the exciter circuits for one frequency channel. It is recommended that the r-f circuit adjustment for each channel be completed, by tuning the intermediate amplifier power amplifier and antenna coupling circuits, before going on to the next channel.

4.6.3. Intermediate Amplifier Tuning. The tank circuit mounted in the Power Amplifier Unit combines the intermediate amplifier plate tank and power amplifier grid tank circuits.

The INT. AMP. BAND SWITCH positions and the approximate frequency range covered by each are listed below:

INT. AMP. BAND SWITCH Position	Frequency Range
1	15.0 mc to 18.1 mc
2	12.5 mc to 15.0 mc
3	10.5 mc to 12.5 mc
4	8.0 mc to 10.5 mc
5	6.5 mc to 8.0 mc
6	5.0 mc to 6.5 mc
7	4.0 mc to 5.0 mc
8	3.2 mc to 4.0 mc
9	2.5 mc to 3.2 mc
10	2.0 mc to 2.5 mc

(a) Unlock the Autotune stop rings on the INT. AMP. BAND SWITCH and the INT. AMP. TUNING Controls.

(b) Refer to the table above and operate the INT. AMP. BAND SWITCH to the range position that contains the frequency upon which operation is desired. Always approach the switch position in a clockwise direction.

(c) Operate the TUNE-OPERATE switch to the H.V. TUNE position.

(d) Operate the LOCAL-REMOTE switch to the LOCAL position.

(e) Apply FILAMENT and PLATE voltages.

(f) Operate the TEST switch and immediately resonate the circuit by operating the INT. AMP. TUNING Control. (Resonance indicated by sharp dip in INT. AMP. PLATE CURRENT.)

If resonance cannot be established, release the TEST switch and try another position of the INT. AMP. BAND SWITCH.

NOTE: Considerable care should be exercised when choosing the position for the INT. AMP. BAND SWITCH. It is possible to obtain the wrong harmonic output from the exciter if the correct position of the switch is not chosen. It should not be necessary to operate the switch more than one position in either direction from those given in the above table for any chosen frequency.

4.6.4. Power Amplifier and Antenna Tuning. The power amplifier plate tank and antenna loading circuits in this transmitter are combined in a pi network. The network is designed to couple the output of the power amplifier to an unbalanced antenna system. The circuit will couple the power amplifier circuit to antennas having impedances of from 50 to 1200 ohms with a phase angle of ±0 degrees, 70 to 850 ohms with a phase angle of ±45 degrees and 100 to 600 ohms with a phase angle of ±60 degrees. (Refer to Fig. 27.)

The POWER AMP. BAND SWITCH positions and the approximate frequency range of each when working into a 300 ohm resistive load are tabulated below:

POWER AMP. BAND SWITCH Position	Frequency Range
1	16.5 mc to 18.1 mc
2	14.0 mc to 16.5 mc
3	11.0 mc to 14.0 mc
4	7.8 mc to 11.0 mc
5	5.4 mc to 7.8 mc
6	3.5 mc to 5.4 mc
7	3.0 mc to 3.5 mc
8	2.6 mc to 3.0 mc
9	2.2 mc to 2.6 mc
10	2.0 mc to 2.2 mc

IMPORTANT: When a frequency in the range 4.0 mc to 18.1 mc has been chosen, select the POWER AMP. BAND SWITCH position so that resonance of the power amplifier plate tank circuit is obtained with the POWER AMP. TUNING Control set to near minimum capacity. When a frequency in the range 2.0 mc to 4.0 mc is chosen, choose the POWER AMP. BAND SWITCH position that permits tuning with the greatest amount of capacity.

While the exact settings of the control will depend to a large extent upon the type of antenna that is being used, the general procedure outlined below for the tuning of the power amplifier and antenna coupling circuits should be followed:

(a) Unlock the stop rings on the three Autotune units on the Output Network Unit.

(b) Refer to the table above and operate the POWER AMP. BAND SWITCH to the range position that contains the frequency upon which operation is desired.

(c) Operate the ANTENNA TUNING Control to approximately mid-scale.

(d) With the TUNE-OPERATE switch in the H.V. TUNE position and the LOCAL-REMOTE switch in the LOCAL position, apply FILAMENT and PLATE voltages.

(e) Operate the TEST switch and immediately attempt to resonate the power amplifier plate tank circuit by operating the POWER AMP. TUNING Control. (Resonance indicated by sharp dip in PWR. AMP. PLATE CURRENT.) If resonance cannot be established, operate the ANTENNA TUNING Control about 25 divisions in either direction and make another attempt to resonate the circuit.

(f) If it is impossible to obtain resonance no matter where the ANTENNA TUNING Control is set, release the TEST switch and try another position of the POWER AMP. BAND SWITCH and repeat Step (e).

WARNING: BE CAREFUL NOT TO DOUBLE FREQUENCY IN THIS STAGE. REFER TO TABLE OF BAND SWITCH POSITIONS VERSUS FREQUENCY RANGE.

(g) Using the ANTENNA TUNING Control, load the power amplifier stage until the PWR. AMP. PLATE CURRENT meter indicates 0.4. amp. While increasing the loading with the ANTENNA TUNING Control, keep the tank circuit in resonance with the POWER AMP. TUNING Control. The ANTENNA TUNING Control should be operated toward 0 dial setting to increase loading.

(h) Operate the TUNE-OPERATE switch to the OPERATE position and repeat Step (g) until the PWR. AMP. PLATE CURRENT meter indicates 1.0 amp.

(i) When the loading has been completed, lock the stop rings on the three controls on the Output Network Unit by operating the locking bars in a clockwise direction. (NOTE: ALWAYS APPROACH A DIAL SETTING IN A CLOCKWISE DIRECTION.)

This completes the adjustment of the r-f circuits for one frequency channel. Repeat the procedure outlined under 4.6.1., 4.6.2., 4.6.3., and 4.6.4. for the remaining ten frequency channels. (Note: Channel 11 may be selected by dialing AA1.)

4.7. NEUTRALIZATION. To obtain the best performance from the r-f circuits both the intermediate amplifier and power amplifier circuits require neutralization.

The intermediate amplifier tubes, V105 and V106, are of the pentode type (813). The internal construction of this type of tube greatly reduces the feedback but it has been found that the performance of the stage is greatly improved if a small external neutralizing capacity is added. In this application, an adjustable metal plate has been mounted near the two Type 813 tubes. The amount of capacitance may be changed by moving the plate nearer to or away from the tubes.

A semi-variable capacitor, consisting of two aluminum disks, is used to neutralize the power amplifier stage. The neutralizing capacitor is mounted near the power amplifier tubes, V114 and V115, on the cabinet wall. The capacity may be changed by changing the gap between the two disks. The adjusting screw is held in position by a locking nut.

Both the intermediate amplifier and power amplifier stages were properly neutralized at the factory and the neutralizing capacitors locked in position. No adjustment of these capacitors should be made until it has definitely been proven that the circuit or circuits require some change in feedback capacity. Proper neutralization of a circuit is indicated by the simultaneous occurrence of maximum grid current and minimum plate current of the stage being checked.

Note: The changing of tubes may necessitate reneutralizing a circuit.

4.7.1. Intermediate Amplifier Neutralization. Before changing the position of the plate (capacitor C117), carefully check the operation of the intermediate amplifier stage.

4.7.1.1. Neutralization Check. Follow the procedure outlined below for the checking of the neutralization of this circuit:

(a) Operate the GRID CURRENT switch (top of R-F Exciter Chassis) to the 813 position.

(b) Operate the TUNE-OPERATE switch to the H.V. TUNE position.

(c) Apply FILAMENT and PLATE power.

(d) Unlock the stop rings on the INT. AMP. TUNING Control.

(e) Operate the TEST switch to the locking position.

(f) While observing the INT. AMP. PLATE CURRENT and the EXCITER GRID CURRENT meters, rotate the INT. AMP. TUNING Control through resonance. The INT. AMP. PLATE CURRENT meter should indicate a minimum at the same time as the EXCITER GRID CURRENT meter indicates a maximum.

Note: A slight deviation from the above condition will not materially affect the operation of the transmitter. Due to manufacturing tolerances, it may be impossible to obtain perfect neutralization of the intermediate amplifier circuit.

(g) If the maximum grid current and minimum plate current readings do not occur simultaneously, or nearly so, proceed as outlined under section 4.7.1.2.

(h) Press the PLATE STOP switch.

4.7.1.2. Neutralization Procedure. If it has been proven that some readjustment of the neutralizing capacity is necessary (refer to 4.7.1.1.), proceed as outlined below:

(a) Operate the transmitter circuit breaker to the **OFF** position and operate the TUNE-OPERATE switch to the H.V. TUNE position.

WARNING: DO NOT ATTEMPT ANY NEUTRALIZATION ADJUSTMENTS WITH THE PLATE VOLTAGE (4000 V.) ON. OPENING THE TEST KEY DOES NOT REMOVE PLATE VOLTAGE. PRESS THE PLATE STOP SWITCH.

(b) Open the cabinet door and loosen the two nuts that hold the neutralization capacitor (plate near 813's) in position.

(c) Move the plate (neutralizing capacitor) a fraction of an inch in either direction and close the cabinet door.

(d) Operate the circuit-breaker to the ON position and the LOCAL-REMOTE switch to the LOCAL position.

(e) Press the FILAMENT START switch.

(f) When the time delay relay and interlock relays have operated, press the PLATE START switch.

(g) Loosen the locking bar on the INT. AMP. TUNING Control.

(h) Operate the TEST switch to the locking position.

(i) Rotate the INT. AMP. TUNING Control through resonance while observing the INT. AMP. PLATE CURRENT and EXCITER GRID CURRENT meters. (Proper neutralization is indicated by the simultaneous occurrence of minimum INT. AMP.

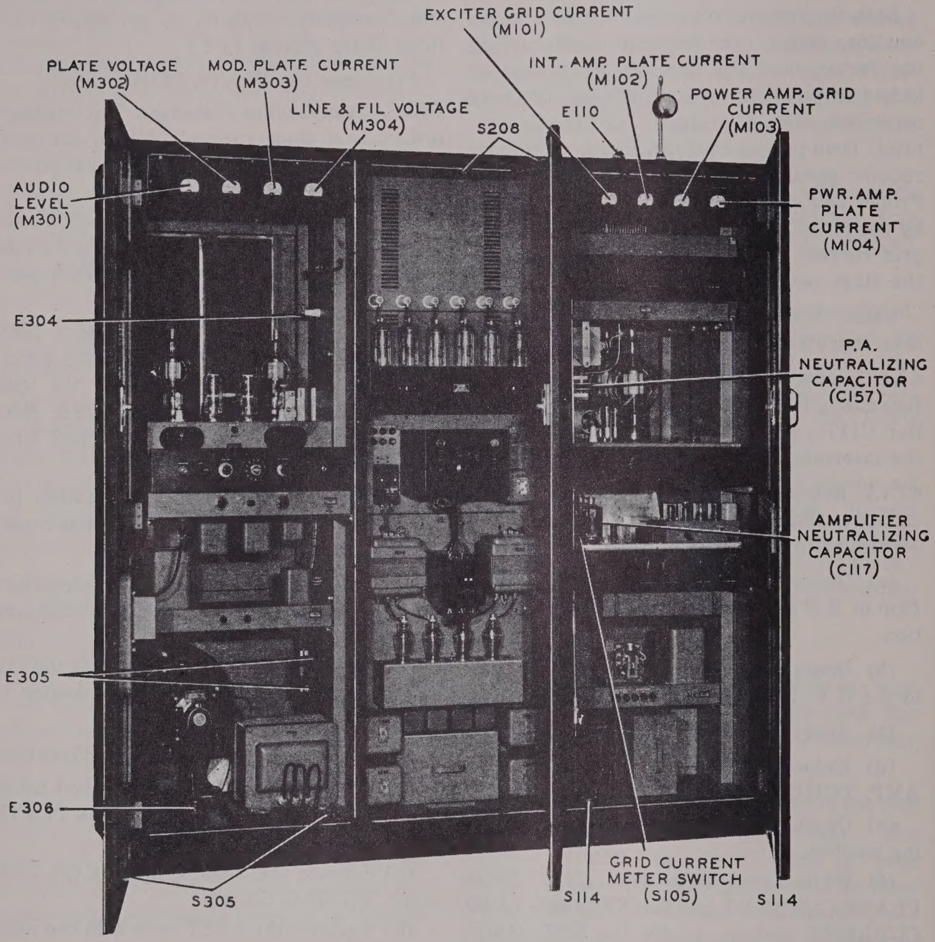

EXCITER GRID CURRENT (M101)
PLATE VOLTAGE (M302)
MOD. PLATE CURRENT (M303)
INT. AMP. PLATE CURRENT (M102)
POWER AMP. GRID CURRENT (M103)
LINE & FIL VOLTAGE (M304)
E110
S208
AUDIO LEVEL (M301)
PWR. AMP. PLATE CURRENT (M104)
E304
P.A. NEUTRALIZING CAPACITOR (C157)
AMPLIFIER NEUTRALIZING CAPACITOR (C117)
E305
E306
GRID CURRENT METER SWITCH (S105)
S305
S114
S114

Fig. 28 Modulator, Power Rectifier and Transmitter Units (Photo No. 8712)

PLATE CURRENT and maximum EXCITER GRID CURRENT.)

(j) If the intermediate amplifier circuit is not properly neutralized, press the PLATE STOP button and try another setting of the neutralizing capacitor.

(k) Repeat Steps (f) thru (i) until the condition stated under Step (i) is met or as nearly as is possible.

(l) Press the PLATE STOP switch and tighten the neutralizing capacitor lock nuts.

4.7.2. Power Amplifier Neutralization. Before changing the air-gap between the disks of the neutralizing capacitor, carefully check the operation of the power amplifier stage to be sure that a change in neutralizing capacity is necessary. The changing of power amplifier tubes does not usually necessitate changing the neutralizing capacity.

4.7.2.1. Neutralization Check. Follow the procedure outlined below for the checking of the neutralization of the power amplifier circuit:

(a) Operate the TUNE-OPERATE switch to the OPERATE position.

(b) Apply FILAMENT and PLATE power.

(c) Operate the TEST switch to the locking position.

(d) While watching the PWR. AMP. PLATE CURRENT and the PWR. AMP. GRID CURRENT meters, rotate the POWER AMP. TUNING Control through resonance. (The PWR. AMP. PLATE CURRENT meter should indicate a minimum at the same time that the PWR. AMP. GRID CURRENT meter indicates a maximum.)

(e) If the condition stated above does not exist, some adjustment of the neutralizing capacity will be necessary.

(f) Press the PLATE STOP switch.

(g) Refer to 4.7.2.2. for the neutralization procedure.

4.7.2.2. Neutralization Procedure. The procedure that is outlined below, should be followed in detail to obtain proper neutralization of the power amplifier circuit:

WARNING: DO NOT ATTEMPT ANY NEUTRALIZATION ADJUSTMENTS WITH THE PLATE VOLTAGE (4000 V.) ON. OPENING THE TEST KEY DOES NOT REMOVE PLATE VOLTAGE. PRESS THE PLATE STOP SWITCH.

(a) After having checked the operation of the power amplifier circuit, as outlined under 4.7.2.1., and with the **PLATE power off**, loosen the locking nut on the lower disk section of the neutralizing capacitor, C157. (Mounted on left-hand inner wall of Navy Type COL-52291 Radio Transmitter Cabinet.)

(b) Using a screwdriver, rotate the adjusting screw a fraction of a revolution.

(c) With the TUNE-OPERATE switch in the OPERATE position and the LOCAL-REMOTE switch in the LOCAL position, apply FILAMENT and PLATE power.

(d) Operate the TEST switch to the locking position.

(e) While observing the PWR. AMP. PLATE CURRENT and PWR. AMP. GRID CURRENT meters, rotate the POWER AMP. TUNING Control through resonance. Record the dial reading of the PWR. AMP. TUNING Control at point of minimum PWR. AMP. PLATE CURRENT. Continue to rotate the tuning control either left or right until the maximum point of PWR. AMP. GRID CURRENT is reached and record this dial reading. Subtract the first recorded reading from the last. If a positive answer is obtained this indicates that the capacity of C157 must be decreased. A negative answer indicates that more capacity is needed. Maximum capacity corresponds to a dial reading of 100, Minimum capacity to zero.

(f) Press the PLATE STOP Switch.

(g) Rotate the capacitor (C157) adjusting screw in the direction indicated by (e), clockwise to increase the capacity, counterclockwise to decrease the capacity. The amount of rotation depends on the magnitude of the difference between the recorded readings.

(h) Press the PLATE START Switch.

(i) Repeat steps (e) through (h) until the difference between recorded readings becomes practically zero.

4.8. AUDIO CIRCUIT ADJUSTMENT. Two adjustments are provided in the speech amplifier in the transmitter, one to regulate the input to the first amplifier stage of the unit and the other to control the amount of compression. When once properly adjusted, the controls will not need any attention until tubes are replaced or the characteristics of the tubes change enough with use to affect the operation of the compression circuit.

A control in the remote control unit permits the adjusting of the input to the audio lines to the transmitter to compensate for variation in line loss.

The adjustments should be begun at the remote control unit.

An audio oscillator capable of putting out 0 db in the frequency range 500 cps to 1500 cps will be necessary in order to make the adjustments of the controls. While not absolutely essential, an oscilloscope is of considerable value when making transmitter adjustments.

The following procedure is recommended for the adjustment of the Audio Controls.

4.8.1. Remote Control Unit Adjustments. This transmitter has been designed for normal operation with the functions controlled by a remote control unit. The distance from which the transmitter may be controlled is determined by the line loss. The loss in the line cannot exceed 25 db or the line loop resistance cannot exceed 1000 ohms. When more than one remote control unit is to be used, preliminary adjustments should first be made on the control unit that is farthest from the transmitter. The procedure outlined below should be followed when making the adjustments of the controls on the remote control unit that is farthest from the transmitter:

(a) Connect the output of the audio oscillator to terminals #2 and #4 on terminal strip E401 on the rear of the Navy Type COL-23351 Remote Control Unit.

(b) Rotate the GAIN control, R401, as far as possible in a counterclockwise direction.

(c) Apply filament and plate power to the tubes in the unit by operating the power switch, S402, to the ON position.

(d) Adjust the audio oscillator frequency to 1000 Kc and partially advance the oscillator gain control.

(e) When the tubes in the remote control unit have reached operating temperature, rotate the GAIN Control in a clockwise direction until the output level meter, M402, indicates zero db. (Zero level -6 mw into 500 ohms.)

(f) Insert the telegraph key cord plug into the KEY jack, J401, and operate the shorting lever to the closed position.

4.8.2. Transmitter Control Adjustments. With the controls on the remote control unit set so that an audio signal of zero db level is being fed into the audio lines, proceed to make transmitter adjustments as outlined below:

4.8.2.1. Speech Amplifier and Limiter Adjustments.

(a) Rotate the AUDIO GAIN and LIMITER GAIN Controls as far as possible in a counterclockwise direction.

(b) Operate the LOCAL-REMOTE switch to the REMOTE position.

(c) Operate the TUNE-OPERATE switch to the OPERATE position.

(d) Close the transmitter cabinet doors and operate the circuit breaker to the ON position.

(e) When the time delay and the interlock relays have operated observe the reading on the AUDIO LEVEL meter in the Navy Type COL-50129 Modulator Unit.

(f) Advance the AUDIO GAIN Control 5 dial divisions.

(g) Observe the level on the AUDIO LEVEL meter.

(h) Adjust the AUDIO GAIN control until the AUDIO LEVEL meter indicates zero db.

(i) Open the modulator cabinet door and advance the LIMITER GAIN Control approximately 5 dial divisions.

(j) Close the cabinet door and when the time delay relay and interlock relays have operated observe the reading on the AUDIO LEVEL meter. (The LIMITER GAIN Control is properly set when the AUDIO LEVEL meter indicates that the output level of the audio drivers has dropped 2 db.)

(k) If the audio level has not dropped 2 db open the cabinet door and advance the LIMITER GAIN Control a fraction of a dial division.

(l) Repeat Step (k) until the AUDIO LEVEL meter does indicate that the output of the audio driver stage has dropped 2 db.

The limiter is very effective and with the controls set as above, the limiter begins operation at approximately 80% modulation. Increasing the input as much as 20 db will not cause over-modulation.

The transmitter is now ready for operation with voice emission. No further adjustment of the AUDIO GAIN and the LIMITER GAIN Controls will be necessary for REMOTE operation.

IMPORTANT: THE LIMITER GAIN CONTROL IS NOW PROPERLY ADJUSTED FOR BOTH THE LOCAL AND REMOTE OPERATION AND UNDER NO CIRCUMSTANCES SHOULD THE SETTING OF THIS CONTROL BE CHANGED.

While observing the AUDIO LEVEL meter on the transmitter proper, have someone speak into the microphone that is used in conjunction with the control unit that is nearest to the transmitter, and have him adjust the GAIN Control on the control unit panel until the meter (transmitter AUDIO LEVEL meter) indicates 0 db on voice peaks.

4.8.2.2. MCW Control Adjustments.

(a) Open the modulator cabinet door and rotate the MCW Gain Control as far as possible in a counterclockwise direction.

(b) Returning to the Remote Control Unit, dial A2.

(c) Return to the transmitter proper, open the modulator cabinet door and advance the MCW GAIN Control 5 dial divisions.

(d) Close the cabinet door and when the time delay relay and interlock relays have operated observe the reading on the AUDIO LEVEL meter. (When the MCW GAIN Control is properly adjusted the AUDIO LEVEL meter will indicate -2 db.)

(e) If the modulation level is too low, open the modulator cabinet door and advance the MCW GAIN Control a fraction of a dial division.

(f) Close the modulator cabinet door and when the time delay relay and interlock relays have operated observe the reading on the AUDIO LEVEL meter.

(g) Repeat Steps (e) and (f) until the AUDIO LEVEL meter indicates -2 db.

The transmitter circuits are now properly adjusted for CW, MCW and VOICE emissions. The circuits are normal for voice emission, that is, when a channel is dialed voice emission is automatically selected. CW or MCW emission may be selected by dialing A1 or A2, respectively.

To complete the control adjustments return to the Remote Control Unit upon which adjustments were made under section 4.9.1., insert the microphone cord plug into plug receptacle J402 and while speaking into the microphone at normal level, adjust the GAIN Control on the Remote Control Unit panel until the needle of the output meter swings up to zero db on voice peaks.

4.9. LOCAL CONTROL (VOICE). If it is desired to operate with LOCAL Control and VOICE emission follow the procedure outlined below for the adjustment of the AUDIO GAIN Control:

(a) Operate the LOCAL-REMOTE switch to the LOCAL position.

(b) Insert the microphone cord plug into the MICROPHONE jack.

(c) Carefully observe the position of the AUDIO GAIN Control so that the control may be reset to this position when returning to REMOTE operation.

(d) Turn the transmitter on by operating the FILAMENT START switch and when the time delay relay and interlock relays have operated press the PLATE START switch.

(e) Dial A3.

(f) Operate the push-to-talk switch on the microphone and while speaking into the microphone at normal voice level observe the reading on the AUDIO LEVEL meter on voice peaks.

(g) Adjust the AUDIO GAIN Control on the modulator bay control panel until the AUDIO LEVEL meter swings up to zero db on voice peaks.

IMPORTANT: WHEN SELECTING MCW EMISSION OR RETURNING TO REMOTE CONTROL BE SURE TO RETURN THE AUDIO GAIN CONTROL TO THE SETTING ESTABLISHED AS BEING CORRECT FOR REMOTE OPERATION.

4.10. EMISSION SELECTION.

While the transmitter connections are normal for VOICE emission, either CW or MCW emission may be automatically selected if the proper connections are made on plug P104 on the R-F Exciter Unit.

If it is desired to operate with CW emission on any or all channels remove the cap from plug P104 and connect the plug terminals to terminal 14 (the terminal numbers correspond to the Autotune channels).

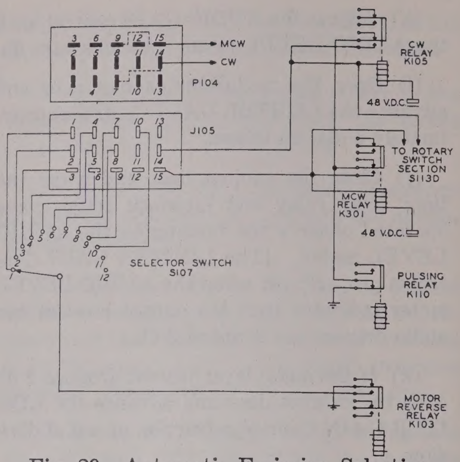


Fig. 29 Automatic Emission Selection Circuit (Dwg. No. 500 4381 00B)

MCW emission will be automatically selected for the Autotune channels if connections are made to plug terminal 15.

If a type of emission other than that which is automatically selected for any particular channel is desired, the desired type of emission may be selected by dialing.

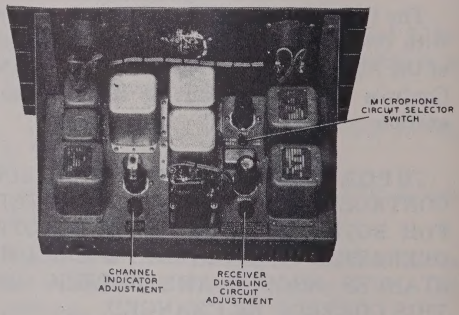

MICROPHONE CIRCUIT SELECTOR SWITCH
CHANNEL INDICATOR ADJUSTMENT
RECEIVER DISABLING CIRCUIT ADJUSTMENT

Fig. 30 Remote Control Unit (Photo No. 8713)

4.11. CHANNEL INDICATOR AND DISABLING CIRCUIT ADJUSTMENT

4.11.1. Channel Indicator Adjustment. The Remote Control Unit has been provided with a channel indicator so that the operator at the remote position may see on which frequency channel the transmitter is operating. The meter is a voltmeter with a scale graduated to show the channel numbers.

A variable resistor, R410, has been connected between the meter and ground. The operating knob is located on the top rear edge of the chassis. To set the indicator, dial a channel, preferably Channel 5 or 6 and when the meter needle has come to rest, rotate the adjusting knob until the needle is opposite the number of the channel that was dialed. Check the operation of the CHANNEL INDICATOR by dialing several other channels and observing the position of the meter needle. Dial A0 and check to see that the meter needle comes to rest opposite OFF on the meter dial.

4.11.2. Receiver Disabling Circuit Adjustment. A receiver disabling circuit has been incorporated in the remote control unit. The relay, K401, releases when the push-to-talk switch on the microphone is pressed or the telegraph key is closed. A variable resistor, R421, has been connected in the circuit to provide a means of bucking the bias voltage applied to the transmitter keyer which is also applied to the key line under "key up" conditions. The control knob is located on the top rear edge of the chassis.

The transmitter bias supply must be on when making the above adjustments.

Follow the procedure outlined below for the adjustment of the receiver disabling circuit:

(a) Rotate the circuit control, R421, as far as possible in a counterclockwise direction.

(b) Close the telegraph key.

(c) If the relay releases no further adjustment will be necessary.

(d) If the relay does not release when the key is pressed release the telegraph key and rotate the control in a clockwise direction until the relay operates.

(e) Check operation of the circuit by opening and closing the telegraph key.

Note: Where more than one remote control unit is being used begin adjustment of the receiver disabling circuits by rotating the control on one unit as far as possible in a counterclockwise direction and adjusting the other as outlined above. When one circuit is operating correctly adjust the other.

WARNING: THE RECEIVER DISABLING CIRCUIT ADJUSTMENT SHOULD NOT BE ROTATED FARTHER CLOCKWISE THAN NECESSARY FOR PROPER OPERATION OF RELAY K401 AS IT MAY PLACE SUFFICIENT VOLTAGE ON THE CARRIER CONTROL LINE TO OPERATE THE TRANSMITTER CARRIER CONTROL CIRCUIT.

4.12. KEYING VOLTAGE ADJUSTMENT.

For best transmitter performance, the voltage that is applied to the cathode of the keyer tube, V109, and the cathode of the audio squelch tube, V303, should be **-25 volts.** The potentiometer has been connected across the output of the bias supply so that the voltage that is applied to these cathodes may be adjusted. The potentiometer, R217, is mounted on the rear of the vertical chassis.

The procedure outlined below should be followed for the checking and adjustment of the keying voltage:

(a) Operate the circuit breaker to the OFF position.

(b) Open the rear door of the Navy Type COL-52291 Radio Transmitter Unit cabinet.

(c) Connect a d-c voltmeter between the chassis and terminal #37 on plug receptacle J309.

(d) Open the front door of the Navy Type COL-20196 Rectifier Power Unit cabinet and operate the ADJUST-OPERATE switch to the ADJUST position.

(e) Close the front door of the Rectifier Power Unit.

(f) Operate the circuit breaker to the ON position.

(g) Operate the TUNE-OPERATE switch to the L.V. TUNE position.

(h) Press the FILAMENT START switch.

(i) When the time delay relay and interlock relays have operated press the PLATE START switch.

(j) Observe the reading on the voltmeter. If the meter does not indicate -25 volts some adjustment of the potentiometer will be necessary. If some adjustment of the keying voltage is necessary, proceed as follows:

1. Operate the circuit breaker to the OFF position.

2. Open the rear door of the Navy Type COL-20196 Rectifier Power Unit. Remove the lock nut from potentiometer R217 (potentiometer nearest left hand edge of vertical chassis, as viewed from the rear).

3. Using a screwdriver, rotate the potentiometer shaft to raise or lower the keying voltage as necessary. (To raise the voltage, rotate the shaft a few degrees in a clockwise direction.)

4. Close the rear door of the Navy Type COL-20196 Rectifier Power Unit cabinet, operate the circuit breaker to the ON position and apply FILAMENT and PLATE voltages.

(k) Check the voltage by observing the reading on the voltmeter.

(l) Repeat Step (j) until the voltmeter indicates -25 volts.

4.13. MODULATOR BIAS VOLTAGE ADJUSTMENT. A potentiometer connected in the bias supply output circuit permits the adjusting of the voltage that is applied to the grids of the modulator tubes (V311 and V312). The potentiometer R203, was adjusted at the factory and should not require any further adjustment until the modulator tubes are changed. Even then it may not be necessary to change the setting of the control. The characteristics of tubes vary somewhat and the bias voltage required to give a certain static plate current for one set of tubes may be different from that required to give the same static plate current for another set of the same type of tubes. The setting of potentiometer R203 is not extremely critical but adjustment should be made so that with full voltage on the plates and with no audio input the static plate current, as indicated on the MOD. PLATE CURRENT meter, is between 125 ma and 150 ma.

To check the bias on the modulator tube grids, operate the TUNE-OPERATE switch to the OPERATE position, apply FILAMENT and PLATE voltages and observe the reading on the MOD. PLATE CURRENT meter.

If the reading is below 100 ma or above 200 ma, some adjustment of the bias voltage that is being applied to the modulator tube grids will be necessary. The procedure outlined below should be followed for the adjustment of the bias voltage:

(a) After checking the modulator static plate current, operate the circuit-breaker to the off position.

(b) Open the rear door of the Navy Type COL-20196 Rectifier Power Unit, remove the lock nut from the shaft of R203 (potentiometer nearest center of vertical chassis) and using a screwdriver rotate the potentiometer shaft a few degrees.

IMPORTANT: TO INCREASE THE VOLTAGE THAT IS APPLIED TO THE MODULATOR TUBE GRIDS, (REDUCE THE STATIC PLATE CURRENT) ROTATE THE POTENTIOMETER SHAFT IN A CLOCKWISE DIRECTION.

(c) Close the cabinet door and operate the circuit-breaker to the ON position.

(d) Apply FILAMENT and PLATE power.

(e) Observe the modulator static plate current on the MOD. PLATE CURRENT meter.

(f) Repeat the above procedure until the modulator static plate current is between 100 ma and 200 ma.

V OPERATION

5.1. GENERAL. In compiling this section it has been assumed that all tuning adjustments have been made in accordance with the procedure outlined in the ADJUSTMENT section of this Instruction Book and that all that remains to be done to place the equipment in operation is to operate the controls.

5.2. ROUTINE OPERATING PROCEDURE.

5.2.1. Remote Control. This transmitter has been designed for normal operation with all functions controlled from a remote point. The following steps give a brief outline of the operations that are necessary to set the transmitter up for CW, MCW, and VOICE emissions:

Note: The operation of the time delay relays in the transmitter, applying plate voltage (4000 volts) to the transmitter power amplifier and modulator tubes, is indicated by the operation of the CHANNEL INDICATOR meter on the panel of the Remote Control Unit. If the CHANNEL INDICATOR does not operate within one minute or less, check to be sure that Channel 11 or Manual has not been selected. The CHANNEL INDICATOR will indicate **OFF** in either case.

(a) VOICE Emission.

1. Operate the control unit power switch to the ON position. (IMPORTANT: The transmitter circuit breaker, S211, must be in the ON position and the LOCAL-REMOTE switch in the REMOTE position before assuming control from the Remote Control Unit.)
2. Select a frequency channel by dialing.
3. Operate the push-to-talk switch on the microphone.
4. Speak into the microphone and check the audio level on meter M402.
5. Continue operation using the microphone push-to-talk switch to control the carrier and the telephone dial to select the frequency channels.
6. To turn the transmitter off, dial **A0**.

(b) CW Emission.

1. Operate the control unit power switch to the ON position.
2. Select the desired frequency channel by dialing.
3. Dial **A1** to set up the transmitter circuits for CW emission. (If **A1** emission is not automatically selected.)
4. Insert the key cord plug into the KEY jack.
5. Operate the telegraph key to control the emission.
6. Turn the transmitter off by dialing **A0**.

(c) MCW Emission.

1. Operate the control unit power switch to the ON position.
2. Select the desired frequency channel by dialing.
3. Dial **A2** to set up the transmitter circuits for MCW emission. (If **A2** emission is not automatically selected.)
4. Insert the key cord plug into the KEY jack.
5. When the time delay relay has closed, as indicated by the operation of the CHANNEL INDICATOR, operate the telegraph key to control the emission.
6. Turn the transmitter off by dialing **A0**.

5.2.2. Panel Control. All of the functions of the transmitter may be controlled from the transmitter panel if the LOCAL-REMOTE switch is operated to the LOCAL position.

The following sections list the steps that are necessary to select and control VOICE, CW, and MCW emission from the transmitter panel:

(a) VOICE Emission.

1. Operate the transmitter power switch to the ON position.
2. Operate the LOCAL-REMOTE switch to the LOCAL position.
3. Insert the microphone cord plug into the MICROPHONE jack.
4. Select the desired frequency channel by dialing.
5. Press the FILAMENT START button.
6. When the time delay and interlock relays have operated, apply plate voltages (4000 volts) by pressing the PLATE START button.
7. Press the push-to-talk switch on the microphone and proceed with the transmission.
8. To turn the transmitter off, press the FILAMENT STOP button.

(b) CW Emission.

1. Operate the transmitter power switch to the ON position.
2. Operate the LOCAL-REMOTE switch to the LOCAL position.
3. Insert the telegraph key cord plug into the KEY jack.
4. Select the desired frequency channel by dialing.
5. Select CW emission by dialing A1. (If A1 emission is not automatically selected.)
6. Press the FILAMENT START button.
7. When the time delay and interlock relays have operated apply plate voltage (4000 volts) by pressing the PLATE START button.
8. Operate the telegraph key and proceed with the transmission.
9. Turn the transmitter off by pressing the FILAMENT STOP button.

(c) MCW Emission.

1. Operate the transmitter power switch to the ON position.
2. Operate the LOCAL-REMOTE switch to the LOCAL position.
3. Insert the telegraph key cord plug into the KEY jack.
4. Select the frequency channel by dialing.
5. Select MCW emission by dialing A2. (If A2 emission is not automatically selected.)
6. Press the FILAMENT START button.
7. When the time delay and interlock relays have operated, apply plate voltage (4000 volts) by pressing the PLATE START button.
8. Proceed with the transmission by operating the telegraph key.
9. Turn the transmitter off by pressing the FILAMENT STOP button.

Note: Channel 11 may be selected by dialing AA1. Manual tuning may be selected by dialing AA2. Channel 11 and Manual do not provide automatic emission selection. When Manual is selected the transmitter controls may be operated without disturbing the Autotune mechanism.

WARNING: When dialing Manual (AA2) to set up a frequency independently of the 11 pre-set channels, all dials will come to rest at the extreme clockwise end of travel. No part of the engraved scales are then adjacent to the indicator marks. Therefore, all dials should be rotated COUNTERCLOCKWISE sufficiently to reach the engraved portion of the dials. The dials may then be set up in the normal manner. Failure to observe this precaution may result in the dials slipping on the shafts with consequent invalidation of all calibrations of the 11 pre-set channels.

6.1. AUTOTUNE MAINTENANCE. While the Autotune mechanism has been designed and constructed to give many hours of trouble free service and has been properly adjusted before leaving the factory, some maintenance and adjustment of the units may be necessary to maintain dependable and efficient operation. If it becomes necessary to replace parts of a unit it may be necessary to make some adjustments to obtain proper synchronization between the repaired unit and the other Autotune units in the transmitter.

6.1.1. Lubrication. It is not necessary to remove the individual Autotune units from the casting assemblies for lubrication. If the Autotune cover plates are removed the Autotune units are easily accessible and may be lubricated without dismantling the assemblies. The gears that couple the line shafts to the interconnecting drive shafts are enclosed in small boxes near the left hand ends of the Autotune castings. To gain access to these gears the small cover plates should be removed.

Parts to be lubricated should be given all of the oil that the bearings will take but no excess should be applied. The parts to be lubricated should be kept free of dirt and excessive oil. The grease should be applied in an even thin layer.

WARNING: The Autotune clutches may squeak but under no condition should any lubricant be applied to the clutch band. The squeaking is caused by the friction of the brake band against the brake drum and does not damage the clutch.

A regular schedule for the lubrication of the Autotune mechanism should be established. Some parts require lubrication every month while others will only require lubrication every six months.

Four (4) types of lubricants are required for the Autotune mechanism. It is of utmost importance that the correct type of lubricant be used. The following lubricants have been proven to be most satisfactory for this purpose:

A. Vactra Oil, Extra Heavy X—Produced by the Socony-Vacuum Oil Company.

B. Viscolite Lubricant #10 Grease—Produced by the Socony-Vacuum Oil Company.

C. Petroleum Jelly (vaseline — uncarbolated).

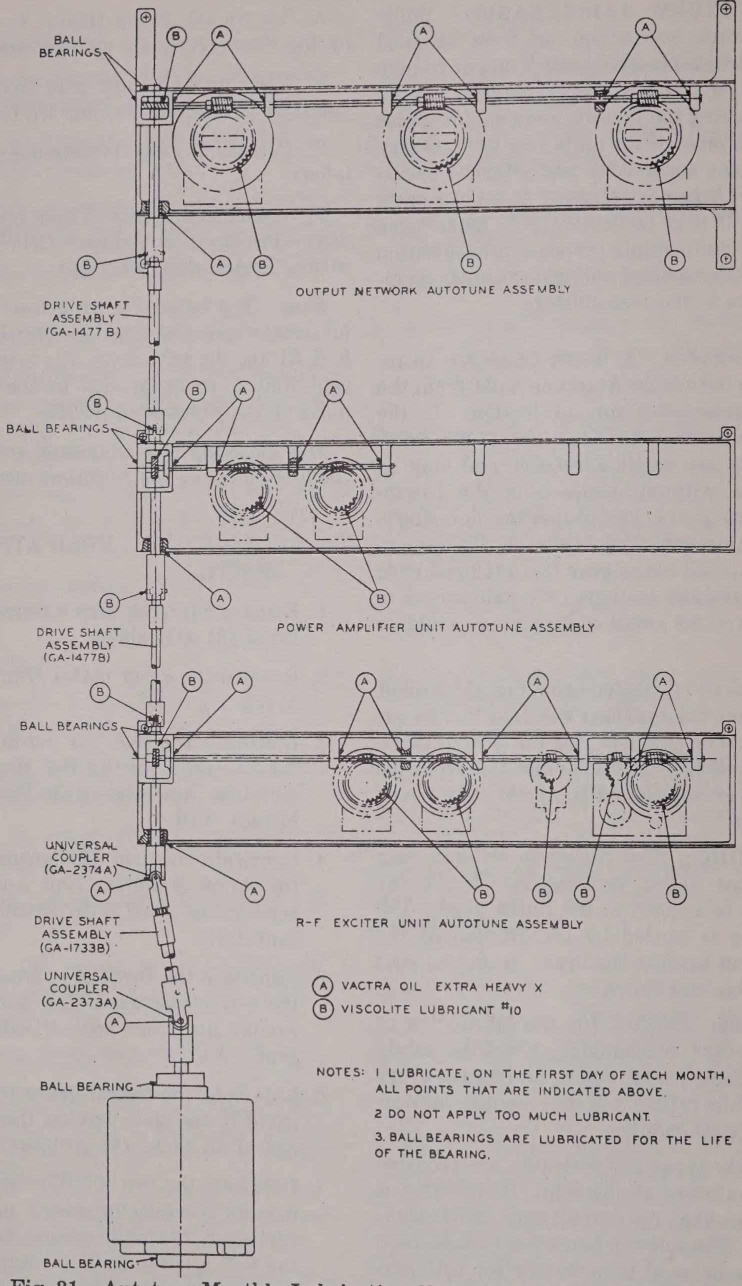
D. Colloidal Graphite (Trade Name Aquadag)—Produced by Acheson Colloids Corporation, Port Huron, Michigan.

Note: The letters shown before the list of lubricants above are used on drawings, Figs. 5, 6, 31 and 32, to indicate the type of lubricant that is to be applied to the Autotune units at the designated points.

The following is a suggested schedule for the lubrication of the Autotune mechanism:

(a) PARTS TO BE LUBRICATED EACH MONTH

1. Remove the Autotune covers from the three (3) assemblies.
2. Remove the cover plates from the gear boxes.
3. Lubricate the five (5) worm gears on the line shaft in the R-F Exciter Unit Autotune assembly with Viscolite Lubricant #10.
4. Lubricate the two (2) worm gears on the Power Amplifier Unit Autotune assembly line shaft with Viscolite Lubricant #10.
5. Lubricate the three (3) worm gears on the Output Network Unit Autotune assembly line shaft with Viscolite Lubricant #10.
6. Lubricate the helical gears that are located in the gear box on the left hand end of all three (3) Autotune castings.
7. Lubricate the two (2) oilite bronze bearings on the selector switch mechanism, the seven (7) oilite bronze bearings in the R-F Exciter Unit Autotune casting, the one (1) oilite bronze bearing in the


BALL BEARINGS
OUTPUT NETWORK AUTOTUNE ASSEMBLY
DRIVE SHAFT ASSEMBLY (GA-1477 B)
BALL BEARINGS
POWER AMPLIFIER UNIT AUTOTUNE ASSEMBLY
DRIVE SHAFT ASSEMBLY (GA-1477B)
BALL BEARINGS
R-F EXCITER UNIT AUTOTUNE ASSEMBLY
UNIVERSAL COUPLER (GA-2374A)
DRIVE SHAFT ASSEMBLY (GA-1733B)
UNIVERSAL COUPLER (GA-2373A)
BALL BEARING
BALL BEARING
A
B

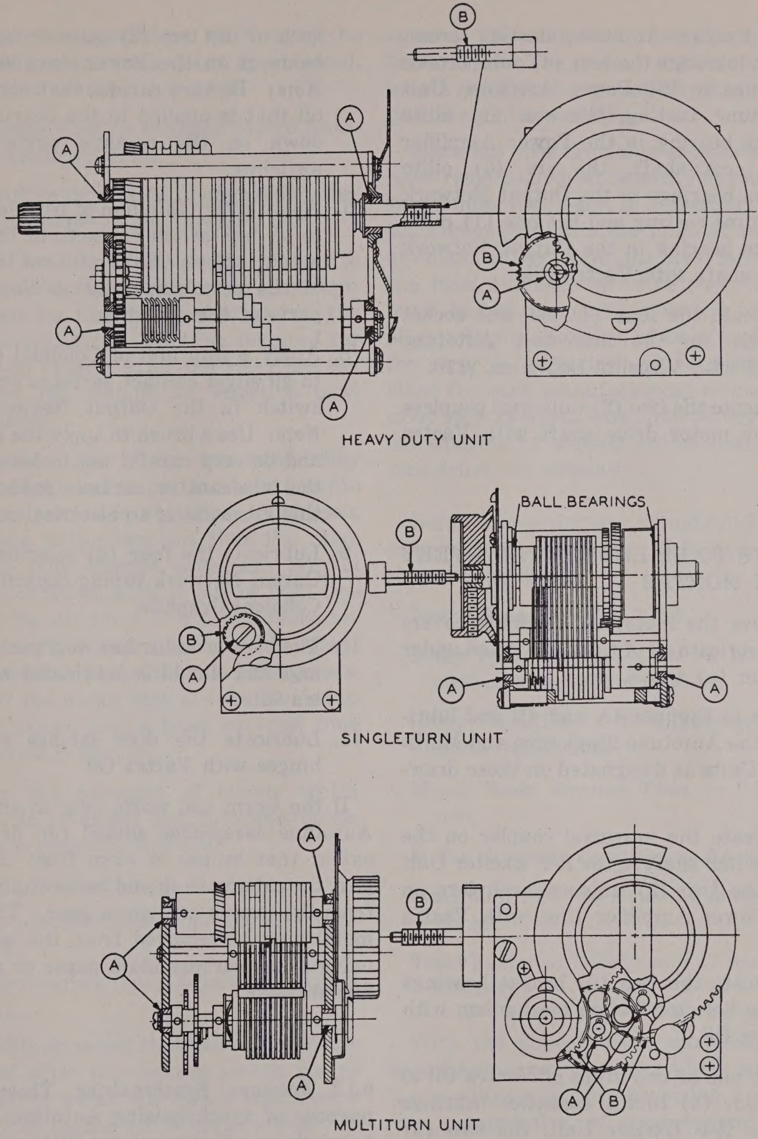
Ⓐ VACTRA OIL EXTRA HEAVY X
Ⓑ VISCOLITE LUBRICANT #10

NOTES: 1 LUBRICATE, ON THE FIRST DAY OF EACH MONTH, ALL POINTS THAT ARE INDICATED ABOVE.

2 DO NOT APPLY TOO MUCH LUBRICANT.

3. BALL BEARINGS ARE LUBRICATED FOR THE LIFE OF THE BEARING.

Fig. 31 Autotune Monthly Lubrication Chart (Dwg. No. 500 6624 00C)



HEAVY DUTY UNIT

SINGLETURN UNIT

MULTITURN UNIT

Ⓐ VACTRA OIL EXTRA HEAVY X

Ⓑ VISCOLITE LUBRICANT #10

NOTES:
1. LUBRICATE EVERY SIX MONTHS, ALL POINTS THAT ARE INDICATED ABOVE.
2. DO NOT APPLY TOO MUCH LUBRICANT.
3. BALL BEARINGS ARE LUBRICATED FOR THE LIFE OF THE BEARING.

Fig. 32 Autotune Semi-Annual Lubrication Chart (Dwg. No. 500 6623 00C)

R-F Exciter Autotune casting cross-shaft, lubricate the four (4) oilite bronze bearings in the Power Amplifier Unit Autotune casting, the one (1) oilite bronze bearing in the Power Amplifier Unit cross-shaft, the six (6) oilite bronze bearings in the Output Network Autotune casting and the one (1) oilite bronze bearing in the Output Network cross shaft with Vactra Oil.

8. Lubricate the four (4) ball and socket couplers on the inter-unit Autotune shafts with Viscolite Lubricant #10.
9. Lubricate the two (2) universal couplers on the motor drive shaft with Vactra Oil.

(b) PARTS TO BE LUBRICATED EVERY SIX MONTHS

1. Remove the Autotune assembly covers and lubricate all of the parts listed under section (a) above.
2. Refer to Figures 4A and 4B and lubricate the Autotune Singleturn and Multiturn Units as designated on these drawings.
3. Lubricate the universal coupler on the tap switch shaft in the R-F Exciter Unit and the two (2) universal couplers on the Power Amplifier Unit with Vactra Oil.
4. Lubricate the two (2) bronze bearings on the Selector Switch mechanism with Vactra Oil.
5. Apply one or two drops of Vactra Oil to the four (4) tuning capacitor bearings in the R-F Exciter Unit, the two (2) tuning capacitor bearings in the Power Amplifier Unit and the three (3) ball bearings at the rear of the Output Network Unit.
6. Apply one or two drops of Vactra Oil to each of the three (3) selector tap switch bearings in the R-F Exciter Unit and to each of the two (2) selector tap switch bearings in the Power Amplifier Unit. **Note:** Be very careful that none of the oil that is applied to the bearings runs down on the ceramic parts of the switches.
7. Apply a very thin film of petroleum jelly to all tap switch contacts in the transmitter. **Note:** Be careful not to get any of the petroleum jelly on the ceramic parts of the switches.
8. Apply a thin film of Colloidal Graphite to all silver contact surfaces on the tap switch in the Output Network Unit. **Note:** Use a brush to apply the lubricant and be very careful not to leave any of the lubricant on ceramic parts because this lubricant is an electrical conductor.
9. Lubricate the four (4) selectors on the Output Network tuning capacitors with Colloidal Graphite.
10. The blower motor has wool packed bearings and should be lubricated with Vactra Oil.
11. Lubricate the door latches and door hinges with Vactra Oil.

If the worm and worm gear in any of the Autotune assemblies should run dry to the extent that bronze is worn from the worm gear the old grease should be carefully cleaned from the worms and worm gear. The galled metal may be removed from the worms by using a fine carborundum paper or a similar fine abrasive.

6.1.2. Autotune Synchronizing Theory. The purpose of synchronizing Autotune heads is to reach an adjustment condition which will assure proper setting up of all Autotune heads under any operating condition within the design limits of the transmitter. Before outlining the correct procedure, a brief explanation will be given of the factors which must be considered in attaining proper synchronism.

There are two conditions which must be met before proper synchronism is obtained. For any given channel, they are:

1. All pawls must be engaged before Autotune motor reverses.
2. No pawl must rise out of engagement before Autotune motor reverses.

To meet these conditions, it is necessary to consider several factors, the most important of which are the time required to operate the motor reversing relay, the time required for the motor to reverse after the relay has operated, and the amount of effective pawl dwell available.

The operate time of the reversing relay may be divided into two parts: a **basic** operate time and an operating variation. The basic operate time is the shortest time the relay requires to fully operate under any normal operating condition, such as low or high line voltage. The variation is the difference between the maximum operate time ever experienced and the basic operate time. The reversing time of the motor may also be divided in the same fashion into a basic reversal time and a reversal variation.

Consider the sequence of events which must occur in reversing the Autotune motor. In order of occurrence they are:

1. Seeking switch makes contact.
2. Relay operates (basic operate plus variation).
3. Motor reverses (basic reversal plus variation).

It is readily apparent that there is a definite time period after the seeking switch makes contact during which the motor will always reverse. This period will begin at a time following occurrence of seeking switch contact equal to the relay basic time plus the motor basic time. The period will be of a time length equal to the sum of the relay variation plus the motor variation.

Since any synchronizing adjustment made must remain fixed, while both relay and motor functioning may vary, it is apparent that the total operating variation (sum of relay variation and motor variation) must never exceed the total available effective pawl dwell. It must, in fact, be considerably less in order to allow a factor of safety, to allow some leeway for error in adjusting synchronism, and to allow for such manufacturing errors as may exist such as deviations from 30 degree nominal spacing of seeking switch contacts, and cam drum slot spacing.

Before computing any actual synchronizing information, some basic facts and relationships will be listed.

Motor Speed = 1725 RPM.

Relay Basic Operate Time = 12 milliseconds -0.36 motor revolutions.

Relay Variation = 10 milliseconds = 0.3 motor revolutions.

Motor Basic Reverse Time = 0.2 revolution.

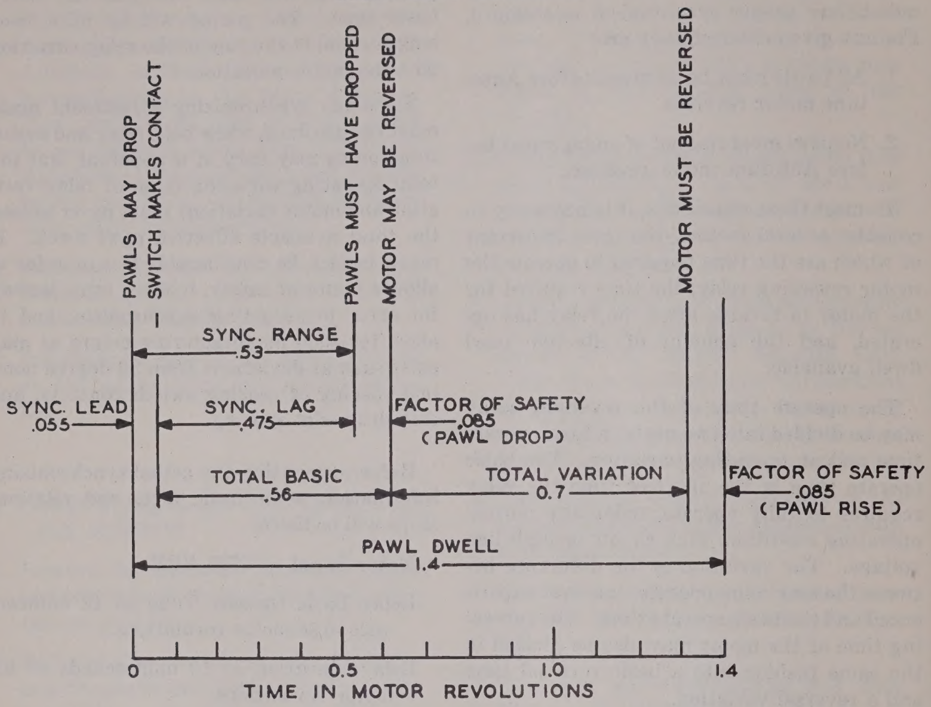
Motor Reversal Variation = 0.4 revolution.

Maximum Pawl Dwell = 1.4 motor revolutions.

Total Factor of Safety = 0.17 motor revolutions.

With the above figures available, a time base diagram can be drawn which will clarify the conditions of synchronizing and enable easy computation of correct synchronizing limits.

TIME BASE DIAGRAM



MOTOR SPEED = 1725 R.P.M.
RELAY BASIC OPERATE TIME = 12 MILLISECONDS – 0.36 MOTOR REVOLUTIONS
RELAY VARIATION = 10 MILLISECONDS – 0.3 MOTOR REVOLUTIONS
MOTOR BASIC REVERSE TIME = 0.2 MOTOR REVOLUTIONS
MOTOR REVERSAL VARIATION = 0.4 MOTOR REVOLUTIONS
MAXIMUM PAWL DWELL = 1.4 MOTOR REVOLUTIONS
TOTAL FACTOR OF SAFETY = 0.17 MOTOR REVOLUTIONS

Fig. 33 Autotune Time Base Diagram (Dwg. No. 500 6622 00B)

Note: Figures shown as distances between vertical lines represent the time in motor revolutions. All calculations assume that the transmitter is being operated from a 60 cps power source.

(1) Seeking switch makes contact.
(2) Motor may be reversed.
(3) Motor must be reversed.
(4) Pawls may drop.
(5) Pawls must have dropped.

$$\text{Synchronizing Range} = 1.4 - 2(0.085) - 0.7$$
$$= 0.53 \text{ motor revolution} \quad \text{Use } 0.52 \text{ rev.}$$
$$\text{Synchronizing Lead} = 1.4 - 0.085 - 0.56 - 0.7$$
$$= 0.055 \quad \text{Use } 0.05 \text{ rev.}$$

The above diagram applies to Collins Type 96J-6, 96J-7, and 96K-2 Autotune Heads. To apply this data to Type 96L-4 Heavy Duty Heads, it is only necessary to apply a correction factor which takes into consideration the different cam drum contour. This type of head employs a milled cam slot of true circular shape, which allows a gradual drop of the pawl, in place of a quick drop. This drum is so designed that the effective pawl dwell is the same as for the 96J series heads. Since the beginning of pawl drop is the most readily found point to synchronize to, a correction factor equal to the distance from the start of pawl drop to the beginning of pawl dwell may be applied to the figures already obtained. This correction factor is equal to 0.91 motor revolution.

To summarize, the requirements of synchronization of Autotune heads are as follows:

Cam drums on 96J-6 Singleturn, 96J-7 Singleturn, 96K-2 Multiturn Autotune Units must be adjusted so that the pawls on any channel do not drop into engagement with cam drum more than 0.05 motor revolutions before, nor more than 0.47 motor revolutions after seeking switch makes contact.

Cam drums on Heavy Duty 96L-4 Singleturn Autotune Units must be adjusted so that the pawls on any channel do not start to drop into engagement with cam drum more than 0.96 motor revolution before, nor less than 0.44 motor revolution after the seeking switch makes contact.

6.1.3. Synchronization Check. If there is reason to believe that the Autotune units are out of synchronization, the following steps should be taken to check the operation of the Autotune system:

IMPORTANT: IN THE FOLLOWING STEPS, THE WORDS "CLOCKWISE" AND "COUNTERCLOCKWISE" ARE USED WITH REGARD TO THE DIRECTION OF ROTATION WHILE VIEWING THE MOTOR FROM THE BOTTOM. **TRANSMITTER POWER MUST BE OFF.**

(a) Remove the Autotune covers from all assemblies.

(b) Manually rotate the drive shaft in a clockwise direction until all cam drums are set in motion. Continue to rotate the drive shaft until the stop ring drum on the multiturn unit has reached home stop and has ceased to turn. (A carpenter's brace and a length of $\frac{5}{16}$ inch rod may be used to advantage.)

(c) After the stop ring drum on the multiturn unit has ceased to rotate and only the cam drums are turning, pull the fork of the anvil in a counterclockwise direction away from beneath the tails of the pawls so that the tails are free to fall to the surface of the counter drum. If at any time the drive shaft should be turned counterclockwise, it will be necessary to turn the shaft again in the clockwise direction far enough to reach home stop before pulling the anvil out from under the tails of the pawls; otherwise, as soon as the line shaft is turned clockwise, the anvil will be rotated up under the tails of the pawls.

(d) Connect an ohmmeter or continuity checker from the common connection to the channel selector switch, S108, to contact No. 5. NOTE: The channel selector switch is wired so that contact No. 1, corresponding to channel number 1, is in line with the common connection and the contacts are numbered in a counterclockwise direction. Thus, contact No. 5 would be on the left side of the switch just below the mounting bolt.

(e) Continue to rotate the drive shaft slowly until the No. 5 pawl on any Autotune unit just drops or channel selector switch just makes contact. NOTE: Count from the front of the Autotune unit toward the back, omitting the first or manual pawl. **The manual pawl on the multiturn unit does not engage the counter drum.** The Heavy Duty 96L-4 Autotune Units do not have a manual pawl.

(f) Note the position of the shaft and then slowly rotate the shaft, noting the points at which the No. 5 pawl on the other units drop and where the switch just makes contact. All of the pawls of the 96J-6, 96J-7 and 96K-2 Autotune Units should drop into place within 0.05 revolution before or 0.47 revolution after the switch just makes contact. (Revolution, as used here, refers to the rotating of the Autotune motor drive shaft.) All pawls should drop sharply with a "click." The pawls of the 96L-4 Heavy Duty Autotune Units should not start to drop more than 0.96 revolution before, nor less than 0.44 revolutions after the seeking switch makes contact.

(g) Repeat steps (d), (e), and (f) checking the operation in turn of channels 6, 7, 8, 9, 10, 11, manual 1, 2, 3, and 4.

If the units located on the R-F Exciter Unit are properly synchronized, but all three singleturn units on the output network are out of synchronization, it may be possible to bring these units into synchronization by removing the short drive shaft that couples the two Autotune assemblies and manually operating the drive shafts until the pawls drop into position on the cam drums under the conditions stated in step (f). If it is impossible to synchronize the two Autotune assemblies in this manner, or if it is impossible to meet the conditions stated in step (f) with one or more of the Autotune heads, it will be necessary to make adjustments on the individual units.

6.1.4. Synchronizing the Autotune System. The complete alignment procedure is outlined below:

(a) Before attempting to synchronize the Autotune system, a synchronizing check should be made as outlined in Section 6.1.3. **Synchronization Check.** This will determine if there is a need for synchronizing.

(b) Align the channel selector switch with the emission selector and channel indicator switch.

(1) Operate the Autotune mechanism electrically several times to determine the position of the rotor contact with respect to the stator contact at the end of each Autotune cycle.

(2) Remove the R-F Exciter Unit from the transmitter and remove the bottom shield.

(3) Center the rotor contacts of the emission selector and channel indicator switch on a stator contact.

(4) Adjust the channel selector switch mounting plate until the rotor contact is in position noted in Step (b) (1). Keep in mind that when the emission selector and channel indicator switch is on contact number 5, the channel selector switch must also be on contact number 5, etc.

(5) Check this adjustment in all positions. The rotor contact of the emission selector and channel indicator switch does not have to be absolutely centered in each position, but should not be far off of center.

(6) When the channel selector switch is properly aligned securely, tighten the channel selector switch mounting plate locking screw.

IMPORTANT: AFTER THE CHANNEL SELECTOR SWITCH HAS BEEN ALIGNED WITH THE EMISSION SELECTOR AND CHANNEL INDICATOR SWITCH, DO NOT CHANGE THIS ADJUSTMENT FOR ANY REASON.

(7) Replace the bottom shield and install the R-F Exciter Unit in the transmitter.

All Autotune heads are factory assembled so that the cam drum adjustment set screws are accessible on channel number 5. The heads are uniformly assembled to castings so that the heads are approximately synchronized to each other. For this reason, synchronizing should ordinarily be done on channel number 5. All following instructions assume that synchronizing is being done on channel number 5, and must be modified if any other channel is being used.

Note that all rotation is specified as viewed from the front of the transmitter. **The drive shaft rotation is always clockwise as viewed from** the bottom of the motor. **TRANSMITTER POWER MUST BE OFF.**

(c) Repeat steps (b), (c) and (d) of Section **6.1.3. Synchronizing Check.**

(d) Continue to rotate the drive shaft slowly until the number 5 pawl of the multiturn unit just drops. NOTE: Count the pawls from the front of the Autotune unit toward the back, omitting the first or manual pawl. **The manual pawl on the multiturn unit does not engage the counter drum.**

(e) Adjust the channel selector switch.

(1) Loosen the two set screws in the switch driving mechanism.

(2) Using a Phillips head screwdriver, rotate the switch in a counterclockwise direction until the switch **just makes** contact as indicated by the ohmmeter or continuity checker.

(3) Rotate the collar in a clockwise direction until all slack is taken up and carefully tighten the set screws.

(4) Check synchronism of channel selector switch and multiturn unit.

(5) The channel indicator dial may be made to read correctly by loosening the Phillips head screw at the center of the dial, rotate the dial until it reads correctly, and tighten the screw.

(f) Repeat Steps (b), (c) and (d) of Section **6.1.3. Synchronizing Check.**

(g) Continue to rotate shaft slowly until the channel selector switch **just makes** contact. At this point the cam drums on the singleturn units should be in a position so that the set screws in the ratchet drum, just to the rear of the cam drum, are accessible. In case one of the set screws is inaccessible, tighten the accessible set screw with a number 6 Bristo wrench and continue to turn the drive shaft clockwise until the set screws can be reached and loosened. After loosening the screw, it will be necessary to continue to turn the drive shaft in a clockwise direction until the channel selector switch **just makes** contact. When this point is reached, the remaining set screws in the ratchet drums should be loosened. In case the above conditions cannot be met, it will be necessary to choose some other channel position that will allow these conditions. The cam drums in the singleturn units are now free to be turned with the fingers.

(h) Insert a 0.005 inch feeler gauge between the rear of the ratchet drum and spacer washer directly behind it.

(i) Rotate the ratchet drum in a clockwise direction and hold it tightly against the internal driving mechanism. Use the set screw wrench to do this and at the same time keep the ratchet drum tight against the spacer shim.

(j) Rotate cam drum counterclockwise until pawl number 5 **just drops** into engagement with the cam drum. Tighten ratchet drum set screws and remove shim.

Synchronize each singleturn unit in order starting with the heads on the R-F Exciter Unit.

After synchronization procedure has been completed, check the synchronism as outlined in Section **6.1.3. Synchronizing Check.**

6.1.5. Replacement of Parts. Since the Autotune mechanism is necessarily complicated, complete shop equipment is required if it becomes necessary to replace many of the parts. Only skilled and experienced personnel should be permitted to replace parts in the Autotune assemblies.

The Autotune parts list has been made up in such a manner that if it becomes necessary to order replacements, complete assemblies should be ordered rather than individual parts. It is deemed impractical to replace parts of assemblies such as the cam drums and therefore, only the part numbers of these assemblies have been included in the list.

REPLACEABLE AUTOTUNE PARTS

Item	Quan.	Description	Used With Item*	Collins Part No.
1	1	Multiturn Autotune Head		96K-2
2	1	Tuning Knob	1	X-5524
3	1	Front Plate Assembly	1	GA-825A
4	1	Rear Plate Assembly	1	GA-826A
5	1	Stop Ring Shaft Assembly	1	GA-1552B
6	1	Cam Drum Shaft Assembly	1	GB-981B
7	1	Pawl Shaft Assembly	1	GA-977B
8	1	Counter Drum Shaft Assembly	1	GB-979B
9	1	Limit Switch Shaft Assembly	1	GA-1553B
10	1	Pawl Spring Bar Assembly	1	GA-842A
11	1	Limit Switch	1	GA-1557B
12	1	Second Idler Shaft Assembly	1	GA-837A
13	1	First Idler Shaft Assembly	1	GA-835A
14	2	Bearing Plate Spacer	1	X-5528-2
15	3	Locking Bar Stop	1, 20, 21	X-5620
16	3	Locking Bar	1, 20, 21	GA-2524A
17	1	Vernier Index Adj. Knob	1	X-6502
18	2	Limit Switch Standoffs	1	X-5532
19	1	Rev. Counter Dial	1	X-6443
20	3	Singleturn Autotune Units		96J-6
21	1	Singleturn Autotune Unit (Int.Amp.Sw)		96J-7
22		Front Plate Assembly	20, 21	GA-843A
23		Rear Plate Assembly	20, 21	GA-844A
24		Pawl Shaft Assembly	20, 21	GA-984B
25		Idler Gear Post Assembly	20, 21	GA-851A
26		Pawl Spring Bar Assembly	20, 21	GA-852A
27		Tension Spring	20, 21	X-6053
28	1	Stop Ring Shaft Assembly	20	GE-983B
29	1	Stop Ring Shaft Assembly	21	GC-983B
30		Cam Drum Shaft Assembly	20, 21	GC-986B
31	1	Line Shaft Assembly		GA-1210C
32	1	Line Shaft	31	X-6466-23⅜
33	4	Worm	31	X-5513
34	1	Worm	31	X-5519
35	1	Helical Gear	31	990NL10
36	1	Gear Bushing	31	X-6463
37	1	Key	31	X-6469
38	1	Collar	31	X-6481
39	1	N. D. Ball Bearing 77R4-A	31	309N137
40	1	Bearing Bushing	31	GA-2100A
41	1	Bearing Retainer	31	X-6488
42	1	1/16 x ⅜ Groov-Pin	31	311NA122T
43	4	1/16 x ¼ Groov-Pin	31	311NA121T
44	1	1/16 x ½ Groov-Pin	31	311NA123T
45	1	1/16 x 5/16 Groov-Pin	31	311NA853T
46	1	Line Shaft Assembly		GA-1297C

REPLACEABLE AUTOTUNE PARTS (Cont.)

Item	Quan.	Description	Used With Item*	Collins Part No.
47	1	Line Shaft	46	X-6466-10-9/16
48	2	Worm	46	X-5513
49	1	Helical Gear L. H.	46	990NL10
50	1	Gear Bushing	46	X-6463
51	1	Key	46	X-6469
52	1	Collar	46	X-6481
53	1	N. D. Ball Bearing 77R4-A	46	309N137
54	1	Bearing Bushing	46	GA-2100A
55	1	Bearing Retainer	46	X-6488
56	2	1/16 x ¼ Groov-Pin	46	311NA121T
57	1	1/16 x ½ Groov-Pin	46	311NA123T
58	1	1/16 x 5/16 Groov-Pin	46	311NA853T
59	1	Line Shaft Assembly		GA-1202C
60	1	Line Shaft	59	X-6581
61	3	Worm	59	X-6589
62	1	Helical Gear R. H.	59	990NL15
63	1	Gear Bushing	59	X-6590
64	1	Key	59	X-6469
65	1	Collar	59	X-6462
66	1	N. D. Ball Bearing	59	309N132
67	1	Bearing Bushing	59	X-6593
68	1	Bearing Retainer	59	X-6464
69	3	3/32 x ⅜ Groov-Pin	59	311NA142T
70	1	3/32 x ⅝ Groov-Pin	59	311NA144T
71	1	3/32 x 7/16 Groov-Pin	59	311NA856T
72	1	Cross Shaft Assembly		1220C
73	1	Cross Shaft	72	X-6474
74	1	Coupler Pin	72	X-6391
75	1	N. D. Ball Bearing 77R-6	72	309N132
76	1	Bearing Retainer	72	X-6464
77	1	Gear Bushing	72	X-6460
78	1	Helical Gear	72	990NL16
79	1	Key	72	X-6465
80	1	Collar	72	X-6462
81	1	3/32 x ⅝ Groov-Pin	72	311NA144T
82	1	Cross Shaft Assembly		1215C
83	1	Cross Shaft	82	X-6487-6-⅛
84	1	Gear Bushing	82	X-6591
85	1	Helical Gear	82	990NL15
86	1	Key	82	X-6465
87	1	Collar	82	X-6462
88	1	N. D. Ball Bearing	82	309N132
89	1	Ball Bearing Retiner	82	X-6464
90	1	Collar	82	X-6481
91	1	3/32 x ⅝ Groov-Pin	82	311NA143T
92	1	3/32 x ½ Groov-Pin	82	311NA144T

REPLACEABLE AUTOTUNE PARTS (Cont.)

Item	Quan.	Description	Used With Item*	Collins Part No.
93	1	Autotune Casting and Cover Assembly		GA-445E
94	1	Line Shaft Assembly	93	GA-1211C
95	1	Cross Shaft Assembly	93	1220C
96	7	Oilite Bearing	93	X-6468
97	1	Oilite Bearing	93	309N558
98	1	Cover Plate	93	X-6467
99	1	Grommet	93	201N203
100	1	Dial Knob (EXCITER TUNING)	93	X-5586
101	1	Bearing Retainer Cap	93	X-6459
102	7	No. 4 Ext. Shakeproof	93	373N801
103	17	4-40 Ph. B. H. Screw ¼ long	93	343N4CXTP
104	1	Bearing Retainer Cap	93	X-6461
105	4	8-36 x ¼ St. Bristo Set Screw	93	335N4FVTP
106	1	Band Switch Knob	93	GA-1536B
107	1	Casting	93	GB-418E
108	2	Felt Seal	93	X-5610
109	1	Autotune Cover	93	GA-516D
110	2	Felt Seal	93	X-5609
111	1	Selector Assembly	93	GA-1144C
112	2	Channel Switch Pie	93	269N36
113	4	Spacer	93	X-5641-½''B1E1
114	4	Dowel Screw	93	X-5601
115	1	Felt Seal	93	X-6490
116	1	Bushing	93	500 0428 00A
117	1	Autotune Casting and Cover Assembly		GA-448E
118	1	Line Shaft Assembly	117	GA-1297C
119	1	Cross Shaft Assembly	117	GA-1220C
120	1	Oilite Bearing	117	309N558
121	4	Oilite Bearing	117	X-6468
122	1	Cover Plate	117	X-6467
123	1	Dial Knob (Int. Amp. Plate)	117	X-5586
124	1	Bearing Retainer Cap.	117	X-6461
125	1	Bearing Retainer Cap.	117	X-6459
126	1	Universal Coupler	117	X-6484
127	1	Coupler Spring	117	GA-2098A
128	1	Casting	117	GB-442E
129	1	Cover Plate	117	X-6467
130	1	Autotune Cover	117	GA-642D
131	1	Band Switch Knob (Int. Amp. Band Sw.)	117	GA-1652B
132	2	Felt Seal	117	X-5610
133	1	Bushing	117	500 0428 00A
134	1	Autotune Casting and Cover Assembly		GA-447E
135	1	Line Shaft Assembly	134	GA-1202C
136	1	Cross Shaft Assembly	134	GA-1215C
137	6	Oilite Bearing	134	X-6628
138	1	Oilite Bearing	134	309N558

REPLACEABLE AUTOTUNE PARTS (Cont.)

Item	Quan.	Description	Used With Item*	Collins Part No.
139	1	Gear Box Cover Plate	134	X-6627
140	1	Box Casting	134	GB-436E
141	1	Bearing Retainer Cap.	134	X-6626
142	1	Bearing Retainer Cap.	134	X-6625
143	1	Universal Coupler	134	X-6484
144	1	Coupler Spring	134	GA-2098A
145	1	Autotune Cover	134	GA-571D
146	3	Felt Seal	134	X-6623-13
147	1	Knob and Dial Assembly	134	GB-1673B
148	2	Knob and Dial Assembly	134	GA-1673B
149	1	Bushing	134	500 0428 00A
150	1	Selector Assembly		GA-1144C
151	1	Shaft Assembly	150	GA-2114A
152	1	Bottom Plate and Standoff Assembly	150	GA-2119A
153	1	Top Plate and Bushing Assembly	150	GA-2116A
154	1	Adjusting Plate	150	X-6441
155	1	Index Plate	150	X-6485
156	1	Channel Indicator Dial	150	X-6486
157	1	Spacer	150	GA-2101A
158	1	Worm Gear	150	X-6431
159	1	Collar	150	X-6431
160	2	Drive Dog	150	X-6437
161	5	Drive Dog	150	X-6436
162	6	Spacer	150	X-6440
163	1	Selector Switch	150	269N37
164	2	Selector Switch Spacer	150	X-5641-⅛B1E1
165	2	Selector Switch Spacer	150	X-5641-3/16B1E1
166	1	Dust Seal	150	X-5534
167	3	Heavy Duty Autotune Head		96L-4
168	1	Stop Ring Drum and Shaft	167	GA-1651B
169	1	Cam Drum and Shaft	167	GB-1636B
170	1	Bar and Springs	167	GA-2283A
171	1	Back End Plate	167	GA-2282A
172	1	Front End Plate	167	GA-2274A
173	1	Pawl Assembly	167	GA-1655B
174	1	Locking Bar and Screw	167	GA-2265A
175	1	Worm Gear	167	GB-1647B
176	1	Cam Shaft Gear Assembly	167	GA-2372A
177	1	Spur Gear Assembly	167	GA-2371A

* Numbers appearing in this column refer to the item numbers listed in the first column of this table.

The above Autotune parts are contained in three assemblies, one on the R-F Exciter Unit, one on the Power Amplifier Unit, and one on the Output Network Unit. The R-F Exciter Unit Assembly contains two singleturn units and a multiturn unit. The Power Amplifier Assembly contains two singleturn units. The Output Network Assembly contains three singleturn units. The singleturn and multiturn units may be removed from the Autotune castings as complete units.

1. Autotune Assembly Dismantling.

(a) Removing the Standard Singleturn Units.

(1) Remove the cover plates from the Autotune assemblies.

(2) Turn dial locking bar to unlocked position and loosen the two #10 Bristo set screws on the dial.

(3) Turn dial and locking bar in a counterclockwise direction until bar comes free. Remove both dial and locking bar.

(4) Remove the dial back plate.

(5) Loosen the two long screws on the top of the unit and the short screw on the bottom of the rear plate and lift the unit out.

(b) Removing the Heavy-duty Singleturn Unit.

(1) Remove 3 $\frac{8}{32}$ Phillips fillister-head screws from the back plate of the Autotune head.

(2) Tip the front of the Autotune head up and pull out.

(c) Removing the Multiturn Unit.

(1) Turn the dial locking bar to the unlocked position and loosen the two #10 Bristo set screws that hold the dial on the stop ring shaft.

(2) Turn the dial and locking bar in a counterclockwise direction until the bar comes free. Remove both dial and locking bar.

(3) Remove the dial back plate from the unit.

(4) Loosen the set screw on the coupler nearest the Autotune casting.

(5) Remove the two mounting screws along the upper edge of the back plate of the multiturn unit; also remove the single screw along the lower edge.

(6) Remove the two screws which hold the limit switch and carefully pull the switch away from the assembly.

(7) Carefully pull the assembly out of the casting, being very careful not to turn the tuning slug on the leadscrew.

Note: **If the leadscrew is turned even slightly the oscillator must be recalibrated.**

(d) Removing the Line Shaft.

The general procedure for the removal of the line shafts in the two assemblies is very much the same. The only differences in the procedure being that when removing the line shaft from the output network assembly there are three singleturn units to remove; when removing the shaft from the power amplifier assembly there are two singleturn units to be removed; and when removing the shaft from the r-f unit Autotune assembly there are two singleturn and one multiturn units to remove.

The general procedure is as follows:

(1) Remove the Autotune units from the assembly.

(2) Remove the groov-pins from the worm gears.

CAUTION: Be very careful not to spring the line shaft when driving out the groov-pins. Support the shaft adjacent to the gears when removing or replacing the groov-pins. Keep the pins and gears separate and in order so that each may be replaced in the same position on the shaft from which it was removed.

(3) Remove the retainer plate from the left-hand end of the casting.

(4) Slowly work the shaft and bearing assembly out of the casting. Remove each worm as the gear nears the end of the shaft. Place each gear with the proper groov-pin and be sure that each combination is properly identified so as to be replaced in the original position. These gears are not interchangeable.

2. Parts Replacement.

(a) Replacing a Singleturn Worm.

The replacement singleturn worm is furnished undrilled. The following procedure is recommended for replacing a singleturn worm:

(1) Center-punch the sleeve of the worm in the spot corresponding to the center of the larger hole on the old worm.

(2) Using the 1/16″ drill, drill through one side of the worm sleeve.

(3) Slide the worm on the shaft with the sleeve end toward the thrust bearings assembly. Match the hole on the worm sleeve with the hole in the line shaft to which the old gear was pinned. CAUTION: **Do not get the wrong line shaft hole or the smaller end of the correct hole.**

(4) Drill through to the other side of the worm sleeve with the 1/16″ drill.

(5) Drive a new 1/16″ groov-pin into the hole to be sure the new worm will pin properly. Reassemble the line shaft in the reverse order from the foregoing disassembling procedure described under (c).

(b) Replacing a Line Shaft Bearing.

The oilite type line shaft bearings are held in place by means of a press fit. A thin steel sleeve fits over these bearings. After removing the line shaft the defective bearing should be driven out gently, using a mallet and a rod or blunt end punch. The new bearing should then be gently driven into place. Be careful not to deform the bearing.

(c) Replacing the Main Line Shaft Thrust Bearing.

In replacing this bearing, it will not be necessary to remove the entire line shaft assembly. The following procedure is recommended:

(1) Remove the four screws from the bearing retainer plate on the left end of the casting.
NOTE: If the thrust bearing that is associated with the R-F Unit is being replaced it will be necessary to drive the groov-pin out of the multiturn worm.

(2) Work the shaft and bearing out about 3/4 inch from the end of the casting.

(3) Carefully block up the outside bearing collar and drive out the groov-pin from the inside bearing collar. CAUTION: Be careful not to spring the line shaft when driving the pin out.

(4) Remove the bearing and collars, marking the exposed side of the inside collar so that the collar will not be reversed when replaced on the shaft.

(5) Replace the inside collar on the shaft, slide the new bearing onto the shaft and slide the outside collar through the bearing and into the inside collar.

(6) After making sure that the hole on the inside collar and the hole in the outside collar are aligned with the larger end of the line shaft hole, insert the groov-pin and gently drive the pin home. CAUTION: Be sure the outside collar is blocked up properly so that line shaft will not be sprung.

(7) Slide the shaft back to the original position and replace the bearing plate.

(d) Replacing the Line Shaft.

The task of installing a new line shaft is difficult and lengthy and should only be attempted by an experienced mechanic who has adequate tools available.

The following procedure is recommended for replacing the main line shaft:

(1) Remove the line shaft as previously described.

(2) Reassemble the gears on the shaft and drive the groov-pins in lightly.

(3) Carefully measure the distance from the milled end of the shaft to one end of each worm and the thrust bearing.

(4) Completely disassemble the line shaft.

(5) Centerpunch each gear and the sprocket at a point which is at a right angle to the previously used groov-pin hole and the same distance from the end.

(6) Drill each gear through on one side only.

(7) Put one of the worms on the shaft, in the predetermined position, block the shaft well and, using a 1/16″ drill, drill through the new hole in the gear into the line shaft and through the other side of the gear.

(8) Mark the new hole on the sleeve of the gear.

(9) Repeat the steps (7) and (8) for the remaining worms.

(10) Assemble the bearing and slide bearing assembly onto the end of the shaft.

(11) Clamp the bearing, block the shaft and drill through the two sleeves and the shaft at a point at right angles to the old hole. Use a 1/16″ drill.

(12) Mark the new reamed hole on both sleeves.

(13) Using new groov-pins assemble the line shaft while still removed from the casting. Check to be sure there is no play in any of the gears after lightly driving the pins through the holes. **Note:** Be careful not to use the old holes in the worm gears.

(14) Assemble the shaft in the casting as previously described. Note: **Be sure to place the gears in the proper order on the shaft.**

6.2. RELAY MAINTENANCE. Dependable operation of this equipment requires proper operation of all relays. Although each relay used has been chosen because of satisfactory performance in similar service, some of these relays have rather critical adjustments and should not be tampered with.

6.2.1. Telephone Relays. In case of failure of

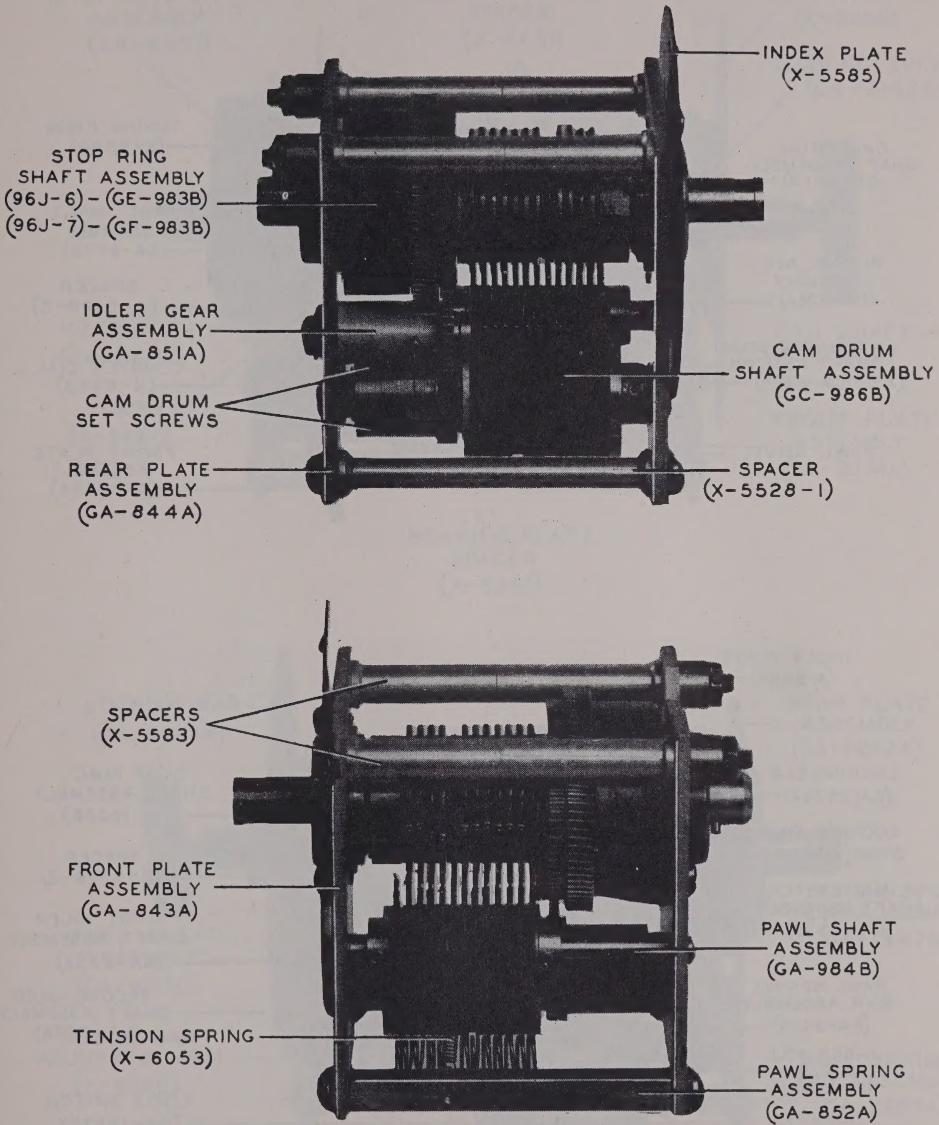

INDEX PLATE (X-5585)
STOP RING SHAFT ASSEMBLY (96J-6)-(GE-983B) (96J-7)-(GF-983B)
IDLER GEAR ASSEMBLY (GA-851A)
CAM DRUM SHAFT ASSEMBLY (GC-986B)
CAM DRUM SET SCREWS
REAR PLATE ASSEMBLY (GA-844A)
SPACER (X-5528-1)
SPACERS (X-5583)
FRONT PLATE ASSEMBLY (GA-843A)
PAWL SHAFT ASSEMBLY (GA-984B)
TENSION SPRING (X-6053)
PAWL SPRING ASSEMBLY (GA-852A)

Fig. 34 Singleturn Unit (Photo No. 8715)

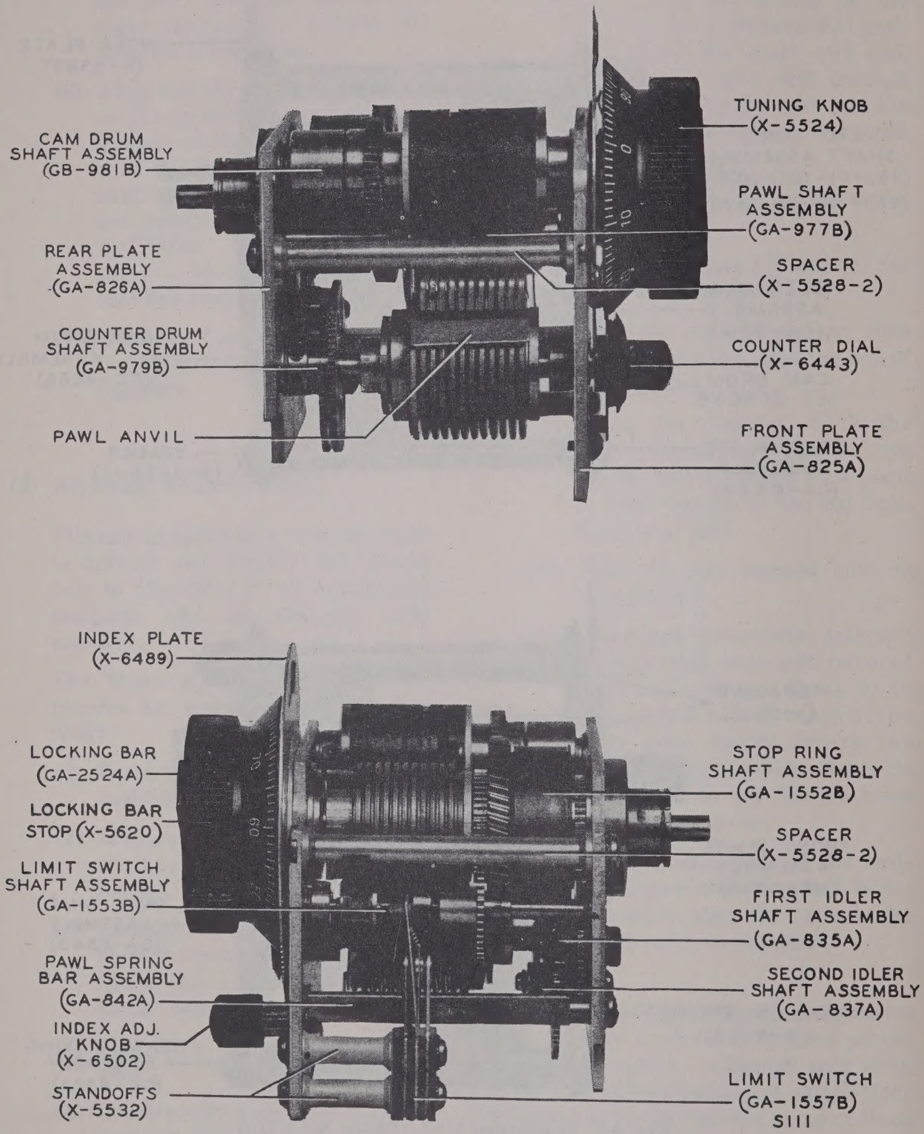

CAM DRUM SHAFT ASSEMBLY (GB-981B)
REAR PLATE ASSEMBLY (GA-826A)
COUNTER DRUM SHAFT ASSEMBLY (GA-979B)
PAWL ANVIL
TUNING KNOB (X-5524)
PAWL SHAFT ASSEMBLY (GA-977B)
SPACER (X-5528-2)
COUNTER DIAL (X-6443)
FRONT PLATE ASSEMBLY (GA-825A)
INDEX PLATE (X-6489)
LOCKING BAR (GA-2524A)
LOCKING BAR STOP (X-5620)
LIMIT SWITCH SHAFT ASSEMBLY (GA-1553B)
PAWL SPRING BAR ASSEMBLY (GA-842A)
INDEX ADJ. KNOB (X-6502)
STANDOFFS (X-5532)
STOP RING SHAFT ASSEMBLY (GA-1552B)
SPACER (X-5528-2)
FIRST IDLER SHAFT ASSEMBLY (GA-835A)
SECOND IDLER SHAFT ASSEMBLY (GA-837A)
LIMIT SWITCH (GA-1557B) S111

Fig. 35 Multiturn Unit (Photo No. 8716)

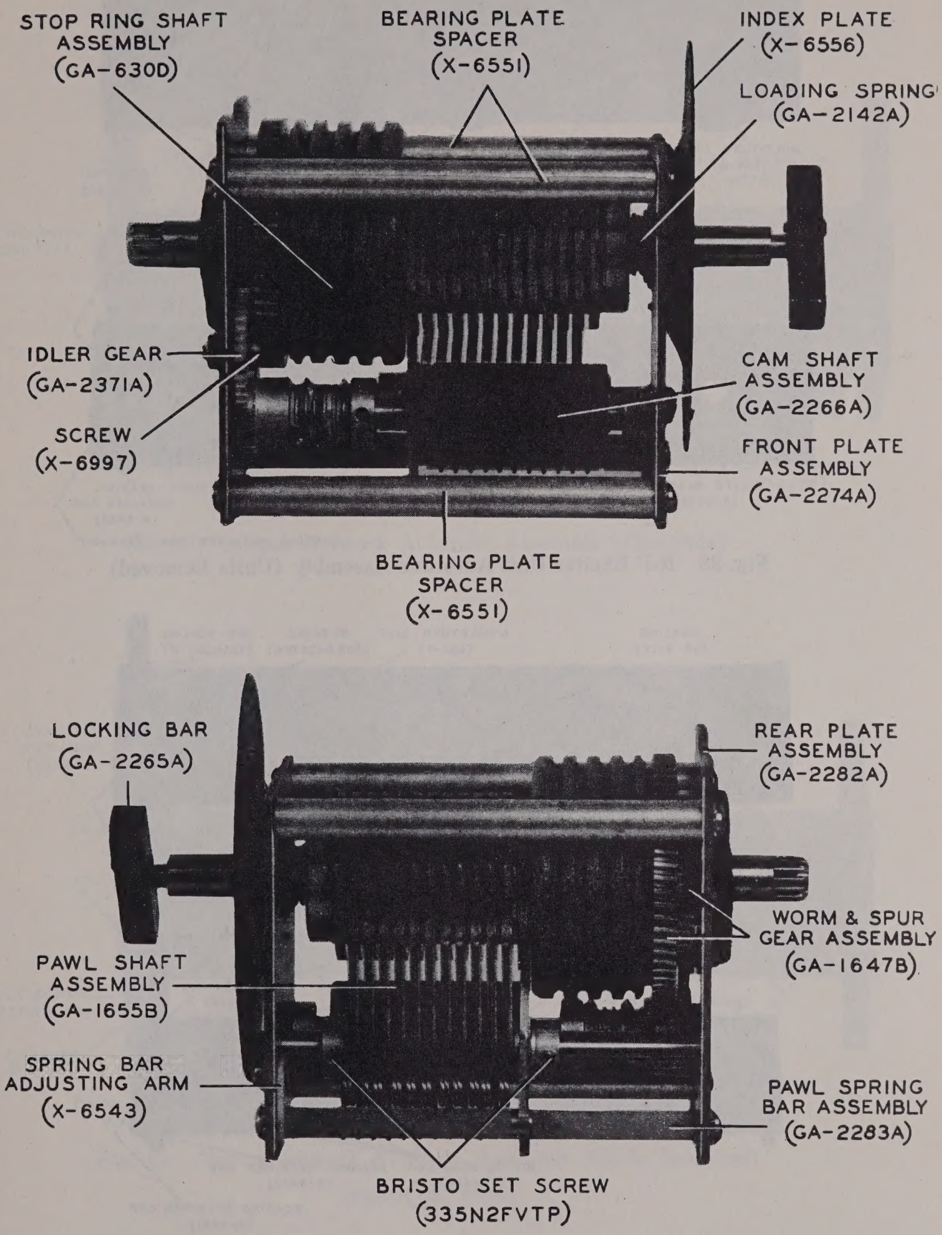

STOP RING SHAFT ASSEMBLY (GA-630D)
BEARING PLATE SPACER (X-6551)
INDEX PLATE (X-6556)
LOADING SPRING (GA-2142A)
IDLER GEAR (GA-2371A)
CAM SHAFT ASSEMBLY (GA-2266A)
SCREW (X-6997)
FRONT PLATE ASSEMBLY (GA-2274A)
BEARING PLATE SPACER (X-6551)
LOCKING BAR (GA-2265A)
REAR PLATE ASSEMBLY (GA-2282A)
WORM & SPUR GEAR ASSEMBLY (GA-1647B)
PAWL SHAFT ASSEMBLY (GA-1655B)
SPRING BAR ADJUSTING ARM (X-6543)
PAWL SPRING BAR ASSEMBLY (GA-2283A)
BRISTO SET SCREW (335N2FVTP)

Fig. 36 Heavy Duty Singleturn Unit (Photo No. 8717)

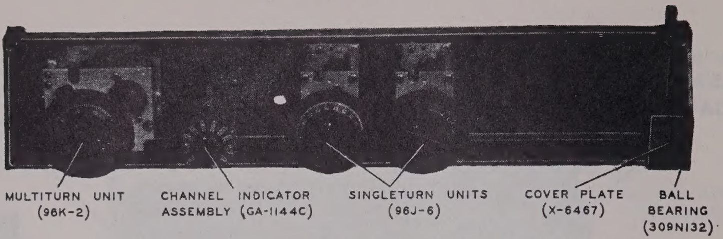


Fig. 37 R-F Exciter Unit Autotune Assembly (Complete)

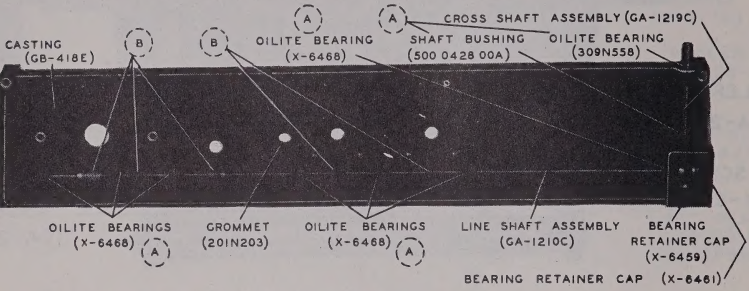

CASTING (GB-418E)
B
B
A
OILITE BEARING (X-6468)
A
CROSS SHAFT ASSEMBLY (GA-1219C)
SHAFT BUSHING (500 0428 00A)
OILITE BEARING (309N558)
OILITE BEARINGS (X-6468)
A
GROMMET (201N203)
OILITE BEARINGS (X-6468)
A
LINE SHAFT ASSEMBLY (GA-1210C)
BEARING RETAINER CAP (X-6459)
BEARING RETAINER CAP (X-6461)

Fig. 38 R-F Exciter Unit Autotune Assembly (Units Removed)

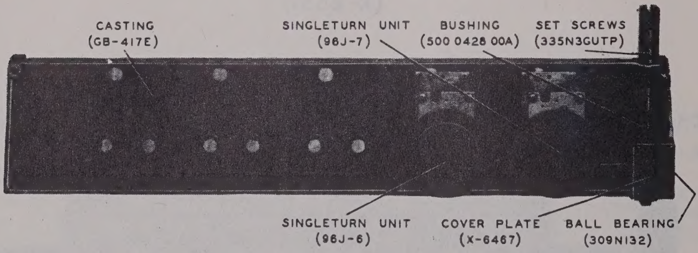


Fig. 39 Power Amplifier Unit Autotune Assembly (Complete)

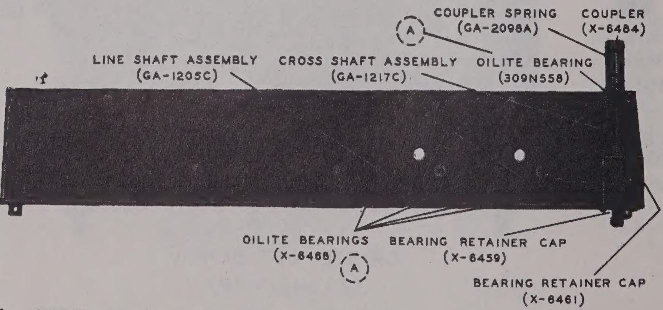

A
COUPLER SPRING (GA-2098A)
COUPLER (X-6484)
LINE SHAFT ASSEMBLY (GA-1205C)
CROSS SHAFT ASSEMBLY (GA-1217C)
OILITE BEARING (309N558)
OILITE BEARINGS (X-6468)
A
BEARING RETAINER CAP (X-6459)
BEARING RETAINER CAP (X-6461)

Fig. 40 Power Amplifier Unit Autotune Assembly (Units Removed)
(Photo No. 8718)

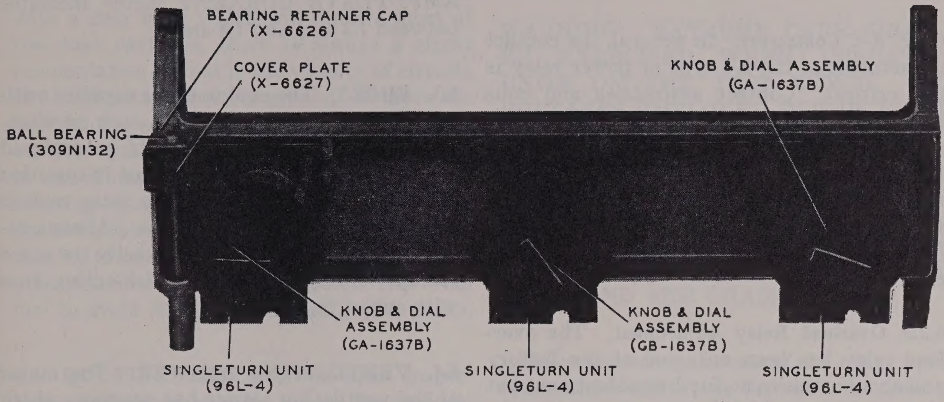


Fig. 41 Output Network Autotune Assembly (Complete)

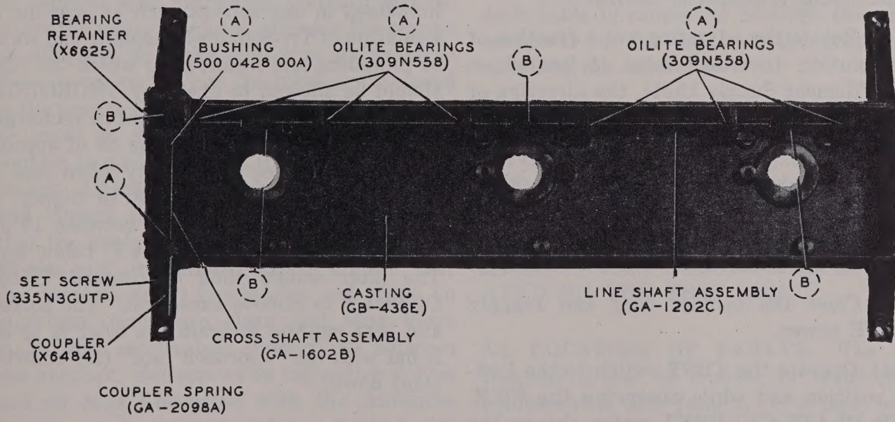


Fig. 42 Output Network Autotune Assembly (Units Removed)
(Photo No. 8719)

the telephone type relays, it is recommended that the entire relay be replaced. The only maintenance recommended is the periodic use of a burnishing tool to clean the contact surfaces.

6.2.2. A-C Contactors. In general, the contact adjustment of the a-c type of power relay is not critical. Contact assemblies and coils may be replaced in case of failure. Never use sandpaper or emery cloth on the contact surfaces. Relays which have excessive hum are usually not seating properly. Dirt on the pole faces is most likely the cause of this, and can be remedied by washing with carbon tetrachloride.

6.2.3. Overload Relay Adjustment. The overload relay has been adjusted at the factory and should require no further adjustment but if the relay should fail to operate when the PWR. AMP. PLATE CURRENT reaches 1.4 amp or if the relay operates when the PWR. AMP. PLATE CURRENT is below 1.1 amp, make adjustments as follows:

(a) Press the PLATE STOP switch and open the front door of the Navy Type COL-52291 Radio Transmitter cabinet.

(b) Rotate the adjusting nut a fraction of a revolution (overload relay is located on P.A. Filament Supply Unit), the direction of rotation depending on the condition that necessitates overload relay adjustment.

Note: To reduce the value of PWR. AMP. PLATE CURRENT at which the overload relay operates, rotate the adjusting nut in a clockwise direction (as viewed from the top).

(c) Close the cabinet door and reapply PLATE power.

(d) Operate the TEST switch to the locking position and while observing the PWR. AMP. PLATE CURRENT meter, detune the power amplifier plate tank circuit.

WARNING: Do not permit the PWR. AMP. PLATE CURRENT to go beyond 1.5 amp.

(e) Carefully check the meter reading at which the overload relay operates.

(f) Repeat Steps (a) through (e) until the overload relay operates when the PWR. AMP. PLATE CURRENT meter indicates between 1.3 amp and 1.4 amp.

6.3. FUSES. The equipment is supplied with fuses of the correct rating in each position. Fuses which have failed should be replaced with spares only after the circuit in question has been carefully examined to make certain that no permanent fault exists. Always replace a fuse with one having exactly the same rating. Do not replace a quick-acting fuse with one of the Slo-Blo type.

6.4. VENTILATING BLOWER. The motor of the ventilating blower has bearings which require lubrication about every six months. Use only Socony-Vacuum Gargoyle Arctic C Light oil or equal.

The air filter in this equipment is of the washable type. When loaded with collected matter it should be removed from the frame of the rear door. The filter should then be immersed in any solvent such as gasoline or a solution of Tri-Sodium-Phosphate and water or Climalene and water, after which the filter should be allowed to dry very THOROUGHLY. Then the filter unit should be recharged as follows: Dip the unit in an oil of approximately SAE 30 or 40 viscosity when used in temperatures of 20 degrees F. or higher, or SAE 10 viscosity when used between 19 degrees F. above and 45 degrees F. below zero. The filter should then be drained THOROUGHLY to remove excess oil. The correct and best method to drain the filter is to lay it flat with the "approach face" (air entering side) down.

6.5. CLEANING. The greatest enemy to uninterrupted service in equipment of this type is corrosion and dirt. Corrosion is accelerated by the presence of dust and moisture on the component parts in the assembly. It is impossible to keep moisture out of the equipment in certain localities, but foreign particles and dust can be periodically removed by means of a soft brush and a dry oil-free jet of air. Although the cabinet is equipped with a dust filter which will remove most of the dust particles, there is always a slight accumulation of dust in the vicinity of circuits at a high potential above ground. Remove the dust by the above method as often as a perceptible quantity accumulates at any place in the equipment. It is very important that rotating equipment such as the variable capacitors, tap switches, etc., be kept free from dust to prevent undue wear. Likewise, variable capacitor plates should be kept free from dirt to avoid flashovers on modulation peaks.

6.6. ROUTINE CHECKS. Routine inspection schedules should be set up for periodic checks of terminals and fastenings as well as examination of the equipment for broken insulators, parts, etc. This inspection should include examination of the mechanical system for excessive wear and of the electrical system for excessive heating of parts. A check on the emission of all vacuum tubes should be made at least every 1000 hours of service. After the emission check, examine the prongs on all tubes to make sure that all are free from corrosion. When the tubes are replaced in the proper sockets, a thorough check should be made to determine that good electrical contact is made between the tube prong and socket. Check all relays for proper operation and inspect relay contacts to make certain that the contact surfaces are clean and free of pits and projections. Make certain that the contacts of all receptacles and plugs on individual units are clean and that these make firm mechanical connections between one another. Set screws on tap switch drives and all dogs associated with the Autotune driving mechanism should be checked and tightened when necessary.

6.7. TEST CABLES. A pair of test cables has been supplied with the equipment. The cables are equipped with the same type of plugs and receptacles as is used in the transmitter proper. These cables are provided to aid in the checking of the R-F Exciter, Speech Amplifier, and Control Units.

WARNING: EXTREME CARE SHOULD BE EXERCISED WHEN OPERATING UNITS ON THE TEST BENCH. THE VOLTAGES EMPLOYED IN THIS EQUIPMENT ARE DANGEROUS TO HUMAN LIFE. WITH THE L.V.-TUNE-OP. SWITCH IN THE L.V. POSITION, THE APPLYING OF PLATE VOLTAGE WILL CAUSE A POTENTIAL OF 500 VOLTS TO EXIST BETWEEN NUMEROUS POINTS IN THE UNITS AND THE CHASSIS.

When servicing any one of the above units, remove the unit from the cabinet, place on the work bench, insert the male cable plug into the plug receptacle in the transmitter cabinet and insert the female cable plug into the receptacle on the unit. **NOTE: Be sure to insert the cable connectors with the side of the connector marked TOP facing upward.** Before applying voltage, check the connectors on both ends of the cables to make certain that each cable is connected between the proper connector on the unit and the proper connector in the cabinet.

WARNING: DO NOT ATTEMPT TO TEST OR OPERATE THE TRANSMITTER WITH THE OUTPUT NETWORK ON THE TEST BENCH. ONLY THE EXCITER STAGES OF THE R-F UNIT WILL OPERATE NORMALLY WHEN THE R-F UNIT IS OPERATED ON THE TEST BENCH.

6.8. LOCATION OF FAULTS. The most frequent cause of trouble in transmitting equipment is tube failure. If a fault occurs in the equipment, each tube should be checked immediately and those found lacking emission replaced with a similar tube from stock. Isolation of the circuit at fault is often helpful in determining the position of the faulty tube.

A check of all fuses should be made immediately if the equipment is inoperative. In case an open fuse is found, it is an indication of an overload in some circuit of the equipment. The overload may be caused by a faulty part, a short circuit due to a foreign particle or a bad electrical connection. Occasionally a high voltage arc may be the cause of fuse failure in an associated circuit. If there is a reason to believe that an arc has occurred, all capacitor plates, tap switches, etc., associated with the circuit should be thoroughly cleaned before placing the equipment back in service. Short circuited components may be readily found by means of an ohmmeter or continuity checker. The d-c resistance of the various circuits may be checked in order to locate the fault.

Defective tubes causing an overload in power circuits may usually be located by inspection. It will be found that excessive heating or sputtering within vacuum tubes is a good indication of fault in the tube circuit. Arc-overs in the high voltage circuit may be caused by bent capacitor plates, corrosion or dust.

It is well known that one of the greatest sources of trouble in equipment located in a salt atmosphere is corrosion. Corrosion resulting from salt spray or salt laden atmosphere may cause failure of the equipment for no apparent reason. In general, it will be found that contacts such as the tap switches, tube prongs, cable plug connectors, and telephone type relay contacts are most affected by corrosion. When it is necessary to operate the equipment in localities subject to such corrosive atmosphere, inspection of wiping contacts, cable plugs, relays, etc., should be made more frequently in order to keep the equipment in good condition.

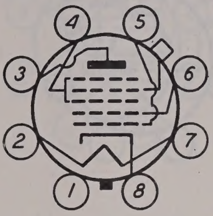
It is good policy when making checks for faults in equipment to refer to the original test data sheets in order to isolate the source of the difficulty. If the section of the equipment in which the fault occurs can be isolated, the trouble may be located with a minimum of effort. Continuity checks and voltage measurements in circuits still operative will be helpful in isolating the trouble. For this purpose an a-c, d-c voltmeter having an internal resistance of not less than 1000 ohms per volt and equipped with a battery for continuity and resistance measurements is necessary. A portable oscilloscope is very useful in running down faults in the radio frequency section of the equipment.

WARNING: OPERATING PERSONNEL SHOULD NOT ATTEMPT TO MEASURE POTENTIALS IN EXCESS OF 250 VOLTS WITHIN THE EQUIPMENT DUE TO HAZARDS TO LIFE.

6.9. TYPICAL VOLTAGES. The following table of Typical Operating Voltages and Currents has been compiled to aid in locating the cause of transmitter failure or erratic operation:

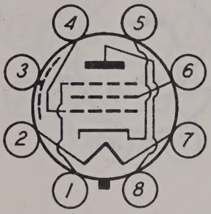
TYPICAL VOLTAGES AND CURRENTS

MASTER OSCILLATOR (V101) 6A8



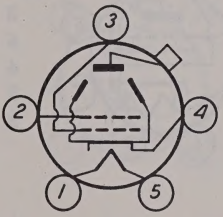
Tube	Pin	Key Open	Key Closed
Filament Voltage	2-7	6.30	6.30
Cathode Voltage	8	–.25	–.55
Grid (G_1) Voltage	5	–8.80	0
Grid (G_2) (Anode) Voltage	6	150.00	150.00
Grid (G_3 & G_5) Voltage	4	0	0
Grid (G_4) Voltage	C	55.00	45.00
Plate Voltage	3	270.00	260.00

R.F. AMPLIFIER (V102) 6AG7



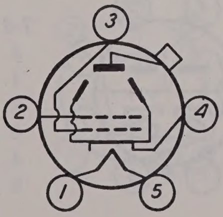
Tube	Pin	Key Open	Key Closed
Filament Voltage	2-7	6.3	6.3
Cathode Voltage	5	5.1	4.8
Screen Voltage	6	185.0	135.0
Grid (G_1) Voltage	4	0	–0.6
Grid (G_1) Current (MA)	4	0	0
Plate Voltage	8	350.0	320.0
Plate Current (MA)	8	10.4	10.4

FREQUENCY MULTIPLIER (V103) 807



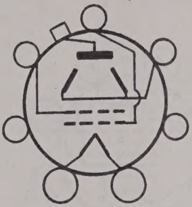
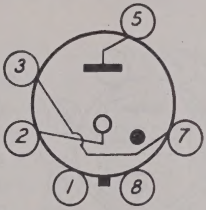
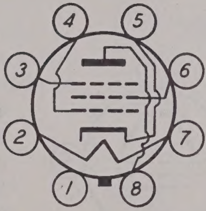
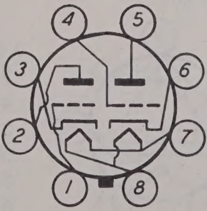
Tube	Pin	Key Open	Key Closed
Filament Voltage	1-5	6.3	6.3
Cathode Voltage	4	0	75.8
Screen Voltage	2	352.0	318.0
Grid Voltage	3	–100.0	–105.0
Grid Current (MA)	M	0	.2
Plate Voltage	3	538.0	538.0
Plate Current (MA)	M	0	15.0

INTERMEDIATE AMPLIFIER (V104) 807



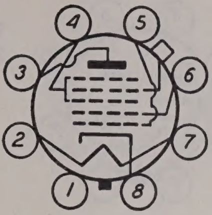
Tube	Pin	Key Open	Key Closed
Filament Voltage	1-5	6.3	6.3
Cathode Voltage	2	0	39.0
Screen Voltage	4	352.0	318.0
Grid Voltage	3	–95.0	–235.0
Grid Current (MA)	M	0	3.8
Plate Voltage	3	538.0	538.0
Plate Current (MA)	M	0	50.0

TYPICAL VOLTAGES AND CURRENTS (Cont.)

Tube	Pin	Key Open	Key Closed
INTERMEDIATE AMPLIFIER (V105-106) 2-813's			
			
Filament Voltage		9.8	9.8
Screen Voltage		550.0	300.0
Grid Voltage (CW)		–100.0	–145.0
Grid Current (CW) (MA)		0	16.0
Plate Voltage (CW)		2000.0	2000.0
Plate Current (CW) (MA)		0	325.0
Plate Voltage (Phone)		2000.0	1950.0
Plate Current (Phone) (MA)		0	310.0
VOLTAGE REGULATOR (V107) VR150-30			
			
Cathode	2	0	0
Plate	5	150.0	150.0
KEYER (V109) 6SJ7			
			
Filament Voltage	2-7	6.6	6.6
Cathode Voltage	5	–25.5	–28.5
Screen Voltage	6	0	0
Grid (G_1) Voltage	4	–25.5	–58.0
Grid (G_3) Voltage	3	–25.5	–28.5
Plate Voltage	8	–8.8	0
		Operating	
CFI CONVERTOR (V110) 6SL7GT			
			
Filament Voltage	7-8	6.6	
Cathode Voltage	3	0	
Grid Voltage	1	–9.2	
Plate Voltage	2	52.0	
Cathode Voltage	6	0	
Grid Voltage	4	–13.0	
Plate Voltage	5	165.0	

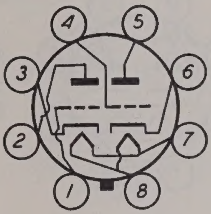
TYPICAL VOLTAGES AND CURRENTS (Cont.)

CFI OSCILLATOR (V111) 6A8



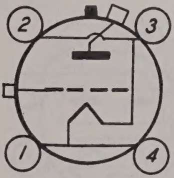
Tube	Pin	Operating
Filament Voltage	2-7	6.6
Cathode Voltage	8	0
Grid (G_1) Voltage	5	–17.5
Grid (G_2) Voltage	6	210.0
Grid (G_3 & G_5) Voltage	4	125.0
Grid (G_4) Voltage	C	–11.5
Plate Voltage	3	210.0

CFI AMPLIFIER (V113) 6SN7GT



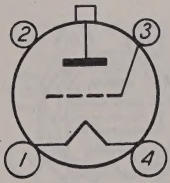
Tube	Pin	Operating
Filament Voltage	7-8	6.6
Cathode Voltage	3	9.2
Grid Voltage	1	0
Plate Voltage	2	275.0
Cathode Voltage	6	3.6
Grid Voltage	4	0
Plate Voltage	5	130.0

POWER AMPLIFIER (V114-V115) 2-750TL's



	No Mod.	100% Mod.
Filament Voltage	7.2	7.2
Grid Voltage	–500.0	–1100.0
Plate Voltage	4200.0	4050.0
Plate Current (MA)	0	1000.0

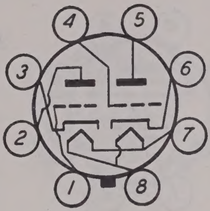
PARASITIC SUPPRESSOR (V116) 811



	Key Open	Key Closed
Filament Voltage	6.6	6.6
Cathode Voltage	–500	–500
Grid Voltage	–500	–1100
Plate Voltage	–500.0	–1100.0

TYPICAL VOLTAGES AND CURRENTS (Cont.)

PREAMPLIFIER (V301) 6SL7GT



Tube	Pin	No Mod.	100% Mod.
Filament Voltage	7-8	6.1	6.1
Cathode Voltage	3-6	1.3	1.5
Grid Voltage	1	0	0
Plate Voltage	2	112.0	104.0
Grid Voltage	4	0	0
Plate Voltage	5	112.0	104.0

VOLUME LIMITER (V302) 6C8G*

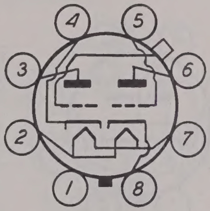
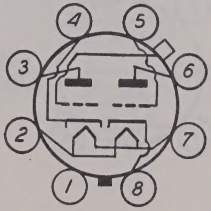


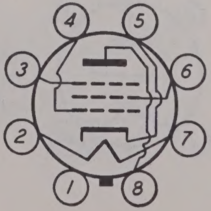
Plate Voltage	6	91.0	85.0
Filament Voltage	2-7	6.1	6.1
Cathode Voltage	8-4	0	0
Grid Voltage	5-C	–7.2	–1.3
Plate Voltage	3	91.0	85.0

SQUELCH (V303) 6C8G



		Key Open	Key Closed (100% Mod.)
Filament Voltage	2-7	6.1	6.1
Cathode Voltage	8-4	–24.0	–25.0
Grid Voltage	5-C	–50.0	–57.0
Plate Voltage	6	91.0	87.0
Plate Voltage	3	91.0	87.0

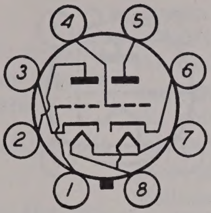
AUDIO AMPLIFIER (V304) 6SJ7



		No Mod.	100% Mod.
Filament Voltage	2-7	6.1	6.1
Cathode Voltage	5	6.6	6.8
Grid Voltage	4	0	0
Plate Voltage	8	209.0	200.0

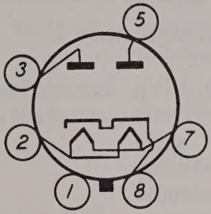
TYPICAL VOLTAGES AND CURRENTS (Cont.)

MCW OSC. (V305) 6SN7GT**



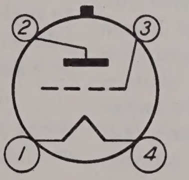
Tube	Pin	Not Osc.	In Osc.
Filament Voltage	6-7	6.1	6.1
Cathode Voltage	3	8.3	8.4
Cathode Voltage	6	4.9	5.9
Grid Voltage	4	0	–2.1
Grid Voltage	1	0	0
Plate Voltage	5	145.0	140.0
Plate Voltage	2	250.0	245.0

LIMITER CONTROL (V306) 6X5GT



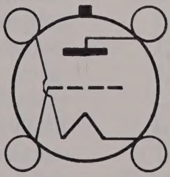
Filament Voltage	2-7	6.1	6.1
Cathode Voltage	8	–7.2	–1.3
Plate Voltage	3	–24.0	–25.0
Plate Voltage	5	–24.0	–25.0

AUDIO AMPLIFIERS (V307-V308) 801's



Filament Voltage	7.4	7.4
Grid Voltage 10 db in comp.	–47.0	–51.9
Plate Voltage	520.0	520.0

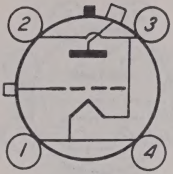
AUDIO DRIVERS (V309-V310) 845's



	No Mod.	100% Mod.
Filament Voltage	9.7	9.7
Grid Voltage	500.0	510.0
Cathode Voltage	720.0	710.0
Plate Voltage	1995.0	1980.0
Plate Current (ma)	110.0	112.0

TYPICAL VOLTAGES AND CURRENTS (Cont.)

Tube	No Mod.	100% Mod.
MODULATORS (V311-V312) 450TL's		
Filament Voltage	7.5	7.5
Grid Voltage	–230.0	–235.0
Plate Voltage	4000.0	4000.0
Plate Current (ma)	150.0	660.0



Notes: 1. All voltages except filament voltages measured between tube terminals and chassis with a vacuum tube voltmeter.

2. Measurements made at an r-f output frequency of 18.1 mc.

* Limiter set 10 db into compression at 100% modulation.

** MCW frequency selector switch set on position 7.

6.10. MASTER OSCILLATOR CALIBRATION. The master oscillator may require calibrating if the multiturn unit has been removed or because of aging of circuit components. The calibration procedure is outlined below:

(a) Remove the R-F Exciter Unit from the cabinet and place the unit on either edge on a table or bench near the transmitter.

(b) Using the test cables, connect the unit to the plugs in the cabinet.

(c) Adjust the indicator mark to the midpoint of the scale.

(d) Rotate the dial to exactly 20.

(e) Remove bottom shield.

(f) Loosen the set screw that holds the coupler to the multiturn shaft.

(g) Operate the TUNE-OPERATE switch to the L.V. TUNE position and turn the transmitter on.

(h) Close test key.

(i) With the dial set to exactly the reading obtained from the Calibration Table and while listening to the output of the CFI Unit, reach beneath the chassis and rotate the lead screw until zero beat note is obtained between the output of the oscillator and the output of the calibration oscillator. Be very careful when rotating the tuning slug lead screw so that the multiturn shaft is not moved.

(j) Carefully tighten the coupler set screw and check the calibration at other points in the band.

6.11. R-F EXCITER CIRCUIT ALIGNMENT. The exciter circuits have been carefully aligned at the factory and should require no further adjustment unless the equipment has been subjected to extremely rough handling or it has been necessary to replace components within the frequency multiplier or intermediate amplifier circuits. Satisfactory alignment is indicated when the EXCITER GRID CURRENT meter indicates intermediate amplifier (813) grid current of not less than 10 ma over the entire frequency range of the transmitter. If the grid drive is lower than the above value, do not attempt any adjustment of the trimmers until all other probable causes of low excitation have been carefully checked. Only realign the exciter circuits as a last resort. Before adjusting any of the inductance or capacitance trimmers in the tank circuits of the frequency multiplier and intermediate amplifier tubes, measure the voltage on each element of each tube in the exciter and compare the voltages with those given in the table of Typical Operating Voltages. Check each tube by replacing with a tube known to be in good condition. Turn the transmitter on after each replacement and check the power amplifier grid current. If all voltages appear to be normal and all exciter tubes are in good condition, it will be necessary to realign the exciter tank circuits to bring the excitation up to normal (10 ma).

6.11.1. General. The alignment of the exciter circuits is accomplished by adjusting tuning slugs within the frequency multiplier and amplifier-tripler plate tank inductors and the adjustment of a trimmer capacitor that is connected across the frequency multiplier plate tank tuning capacitor.

The inductance of the plate tank inductors is determined by the position of the tuning slug within the inductor. The slugs are connected to Phillips head screws so that the inductance of all of the inductors and the capacity of the trimmer capacitor may be varied with a screwdriver from the top of the R-F Exciter Unit Chassis. To adjust the capacity trimmer use a ¼″ spin tight wrench.

Listed below are the exciter tank inductors and the location of each (R-F Exciter Unit viewed from top and front):

Item No.	Location
L110	Right Rear
L111	Left Rear
L114	Right Front
L115	Right—2nd from Front
L116	Left Front
L117	Right—3rd from Front

The trimmer capacitor, C138, is located between inductors L110 and L117.

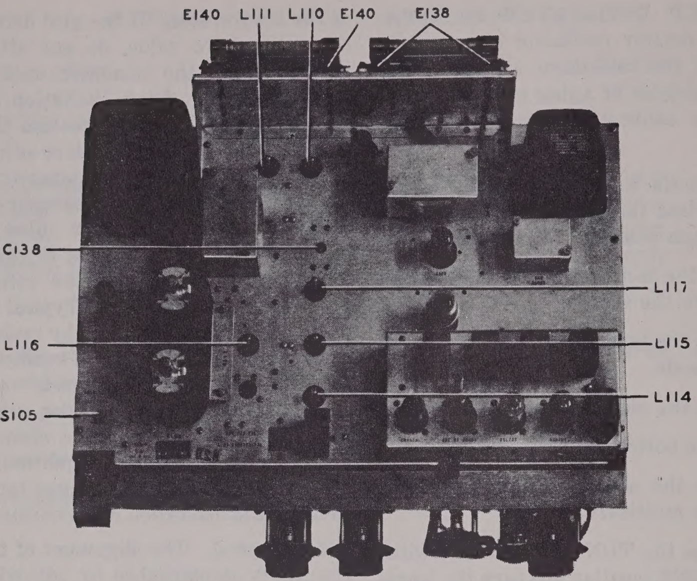


Fig. 43 R-F Exciter Unit

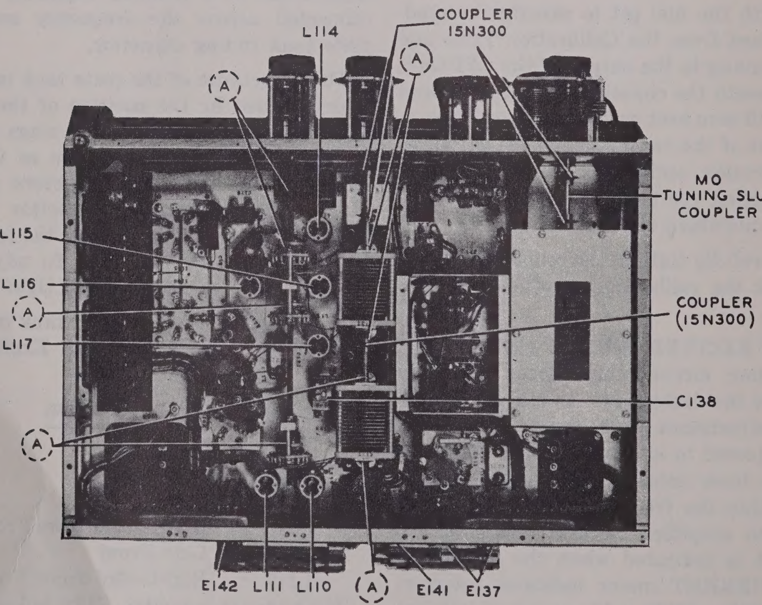


Fig. 44 R-F Exciter Unit (Photo No. 8720)

The proper exciter plate tank inductors for a particular frequency range are selected by the operation of the EXCITER BAND SWITCH. Inductors not in use are shorted out by switches S102 and S103 and S104.

The following table shows the BAND SWITCH positions and the inductors used for each frequency range:

EXCITER BAND SWITCH Position	Frequency Range (Mc)	Inductors Used
4	2.0 to 3.0	L110 & L114
3	3.0 to 6.0	L111 & L115
2	6.0 to 9.0	L110 & L116
1	9.0 to 18.1	L111 & L117

6.11.2. Details. The alignment procedure must be followed in detail and it is recommended that only experienced and skilled personnel attempt the alignment of the exciter circuits.

CAUTION: DO NOT TOUCH ANY EXPOSED WIRING OR TUBE CONNECTIONS. MANY OF THE WIRES AND PLATE VOLTAGE LEADS ARE AT A POTENTIAL OF 500 VOLTS ABOVE GROUND. THE 500 VOLT SUPPLY ASSOCIATED WITH THIS EQUIPMENT HAS SUFFICIENT POWER CAPABILITIES TO BE DANGEROUS TO LIFE. EVEN A MOMENTARY CONTACT WITH THIS SUPPLY WILL BURN DEEP INTO THE FLESH. DO NOT ATTEMPT TO MAKE THE ALIGNMENT ADJUSTMENTS WHILE ALONE.

(The bottom shield cover may be removed for this adjustment.) The exciter alignment procedure is outlined below:

(a) Operate the power level switch to the L.V. TUNE position and the LOCAL-REMOTE switch to the LOCAL position.

(b) With the transmitter circuit-breaker in the OFF position, set trimmer capacitor, C138, at approximately 25% capacity.

(c) Operate the transmitter circuit breaker to the ON position.

(d) Operate the EXCITER BAND SWITCH to Position 1.

(e) Rotate the EXCITER TUNING Control until the dial indicates 95.

(f) Refer to the Calibration Book and obtain the correct dial setting for an output frequency of 18 mc. (The Calibration Data is for the Serial No. transmitter indicated on the Calibration Book only.)

(g) Rotate the OSCILLATOR TUNING Control until the dial is set to the reading obtained under Step (f).

(h) When the time delay and bias interlock relays have operated, press the PLATE START switch, operate the TEST switch to the locking position.

(i) Operate the GRID CURRENT switch to the 807 position.

(j) Adjust the trimmer within inductor L111 for maximum GRID CURRENT reading.

(k) Operate the GRID CURRENT switch to the 813 position.

(l) Adjust the tuning slug within inductor L117 for maximum GRID CURRENT reading.

(m) Rotate the EXCITER TUNING Control to the low end of the scale (5 to 15) and tune for maximum power amplifier GRID CURRENT reading.

(n) Operate the GRID CURRENT switch to the 807 position.

(o) Adjust trimmer capacitor C138 for maximum GRID CURRENT meter reading.

(p) Rotate EXCITER TUNING Control to the high end of the scale (95) and tune for maximum GRID CURRENT reading.

(q) Repeat Steps (k), (l), (m), (n), (o), and (p).

(r) Repeat Steps (q) until exact alignment is obtained between L111 and L117. (Maximum readings at dial settings of approximately 10 and 95.)

Note: Capacitor C138 is now properly adjusted. No further adjustment of this capacitor should be made.

(s) Adjust EXCITER TUNING Control to give maximum power amplifier grid current (dial setting of approximately 95).

(t) Operate the EXCITER BAND SWITCH to Position 3.

(u) Operate the GRID CURRENT switch to the 813 position.

(v) Adjust the tuning slug within inductor L115 for maximum power amplifier GRID CURRENT reading.

(w) Operate the GRID CURRENT switch to the 807 position.

(x) Operate the EXCITER BAND SWITCH to position 2.

(y) Adjust the trimmer within inductor L110 for maximum GRID CURRENT reading.

(z) Operate the GRID CURRENT switch to the 813 position.

(aa) Adjust the tuning slug within inductor L116 for maximum power amplifier grid current.

(bb) Operate the EXCITER BAND SWITCH to Position 4.

(cc) Adjust the tuning slug within inductor L114 for maximum GRID CURRENT reading.

The above procedure completes the alignment of the exciter circuits. The power amplifier grid current should be between 10 ma and 30 ma over the entire frequency range of the transmitter.

The tuning capacitors C127 and C132 were mechanically and electrically tracked at the factory and no further adjustment of these capacitors should be necessary. However, if the final amplifier grid current is less than 10 ma in the middle of the range of Band 1, when it is properly tracked at both ends, it will be necessary to track these capacitors. First, the two capacitors should be mechanically aligned so that maximum capacity of the two capacitors occur simultaneously. The capacitor stators must be properly centered in the rotor. The electrical alignment is accomplished by bending the end rotor plates.

On checking the tracking of the exciter, it will be noticed that the tracking is very poor at the high frequency end of Band 2. This is due to the low distributed capacity of inductor L116. However, with the transmitter tuned so that the 813 grid current is peaked, sufficient drive is obtained to the 813's and the mistuning of L110 will not cause any deleterious effects or objectionable operation.

If it is found that one or more of the bands cannot be made to resonate as outlined it will be necessary to repeat the adjustments using a slightly different dial reading for the high capacity end (93 to 97).

6.12. CFI ADJUSTMENT. The Calibration Frequency Indicator Unit has been carefully adjusted before leaving the factory and unless the unit has been damaged or a new component is being installed, no adjustment of the tank circuits should be attempted.

If, however, it has been definitely proven that the circuits do require realignment, the procedure outlined below should be followed:

a. Remove the CFI Unit from the transmitter by loosening the two securing screws (one on top of chassis between V111 and Z101 and the other between Z104 and the output transformer) and lift the unit upward. Place the unit on a work bench and make power connections from the unit to the transmitter with a test cable.

b. Connect the leads of a high impedance voltmeter, such as a meter of the vacuum tube type, between terminal #5 (G_1) on socket X111 and the chassis.

c. Operate the TUNE-OPERATE switch, S206, to the L.V. TUNE position, the LOCAL-REMOTE switch to the LOCAL position, and apply FILAMENT and PLATE voltages.

d. Operate the CFI Unit power switch, S101, to the ON position.

e. Rotate the tuning screw within tank

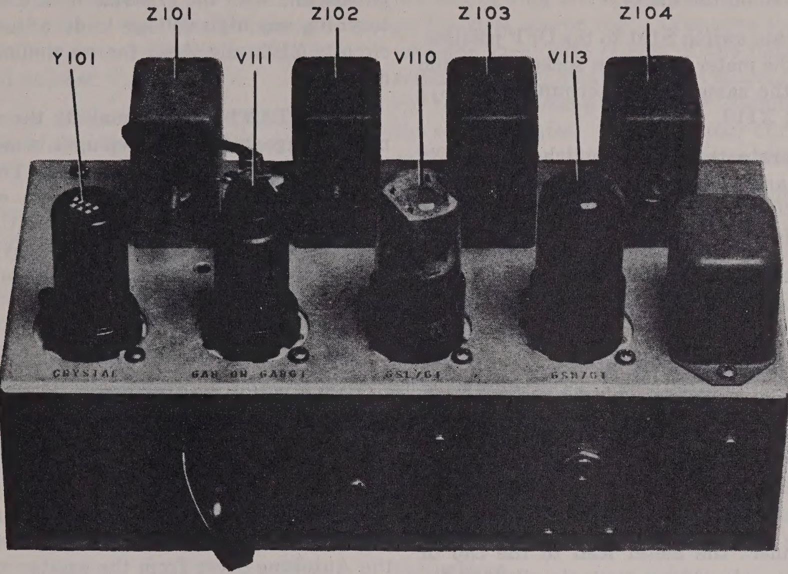


Fig. 45 Crystal Frequency Indicator Unit

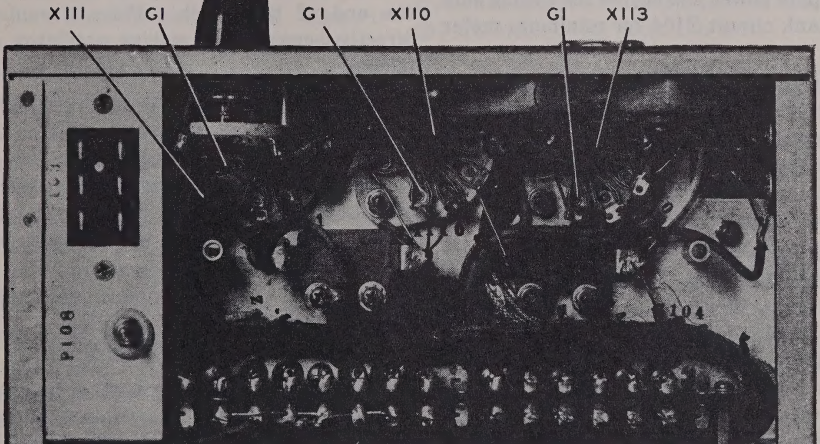


Fig. 46 Crystal Frequency Indicator Unit (Photo No. 8721)

circuit Z101 until the maximum grid voltage is indicated on the meter.

f. Rotate switch S101 to the OFF position, remove the meter lead from socket X111 and connect the same lead to terminal #4 (G_1) of socket X110.

g. Operate the power switch to the ON position and rotate the tuning screw within tank circuit Z102 until a maximum voltage reading is obtained.

h. Operate the power switch to the OFF position and connect the meter lead to the cap of V111 (G_4).

i. Operate the power switch to the ON position and adjust the tuning screw within tank circuit Z103 for maximum voltage.

j. Return the meter lead to terminal #4 (G_1) of socket X110 and readjust tank circuit Z102 for maximum voltage reading.

k. Connect the meter lead to the cap of tube V111 and readjust tank circuit Z103 for a maximum voltage reading.

l. Operate the CFI Unit power switch to the OFF position and connect the meter lead to terminal #4 of tube socket X113.

m. Apply power and adjust the tuning slug within tank circuit Z104 for minimum meter reading.

The above procedure completes the adjustment of the tank circuits of the CFI Unit. Remove the test cable and plug the unit into the R-F Exciter Unit. To check the operation of the CFI Unit the following additional steps are recommended:

n. With the CFI Unit plugged into plug receptacle J103, operate the TUNE-OPERATE switch to the L.V. TUNE position, dial Manual (AA2), operate the TEST switch to the locking position, insert an earphones cord plug into the PHONES jack, operate the CFI power switch to the ON position and while listening to the output of the phones, unlock the OSCILLATOR TUNING Control and rotate the control until an audio beat note is heard.

o. While listening to the output of the phones and with the greatest of care to avoid touching any high voltage leads, adjust tank circuits Z102 and Z103 for maximum audio output.

IMPORTANT: When making the adjustments suggested under Step o., it is most important that the tuning slugs in the two tank circuits be rotated not more than **one-half revolution** in either direction. Rotating the tuning screws more than one-half revolution may detune the circuits until it will be necessary to remove the CFI Unit and to repeat the entire alignment procedure.

6.13. MASTER OSCILLATOR DISASSEMBLY. The following procedure is recommended for gaining access to the components located in the master oscillator compartment:

a. Remove the r-f exciter unit from the transmitter. Remove the bottom shield and the Autotune cover from the exciter unit.

b. Remove the screws that secure the right end casting to the exciter chassis.

c. Place the exciter unit on the edge of the work bench with the end of the unit that contains the master oscillator extending beyond the end of the bench. Place a container directly beneath the master oscillator compartment.

d. Remove the ten screws that hold the shield cover on the master oscillator compartment and allow the puffed mica that surrounds the oscillator coil and heater assembly to fall into the container. Remove all of the puffed mica from inside the oscillator compartment.

e. Remove the eight screws that hold the master oscillator annex shield cover to the annex chassis and lift the shield off.

f. Remove the four screws that secure the master oscillator shield partition to the master oscillator main shield. Two of these screws are accessible from inside the master oscillator annex. **Caution:** Care must be exercised in removing these last two screws to prevent the damaging of components in the master oscillator annex. The lower one of these two screws is most easily removed by using a Phillips screwdriver with a shank ⅛″ in dia. and at least 5″ long.

g. Remove the master oscillator tube shield, disconnect the grid cap and remove the tube (Type 6A8) from the socket.

h. Loosen the oscillator tube grid cap connector post from the inside sufficiently to allow the "feed thru" insulators to slip out of the chassis. The object is to allow the post to be moved freely in all directions.

i. Loosen all of the set screws in the flexible couplings that secure the master oscillator shaft to the Multiturn Unit shaft. Take care that the split reduction sleeve inside the coupler that is adjacent to the oscillator is retained inside the coupling. Slide the shaft and the couplers in the direction of the Multiturn Unit as far as possible.

j. Remove the three screws that hold the coil and heater assembly to the front plate of the oscillator shield.

k. Slide back and raise the front of the coil and heater assembly. Remove the bakelite standoffs and the nuts that hold the front bearing plate and remove the plate. **Caution:** Observe the order of disassembly of the bearing and spring on the oscillator shaft. These two items must be reassembled in the same order.

l. The heater assembly can now be removed. Removal of this assembly exposes the remaining master oscillator components. **Note:** It may be necessary in early models to disconnect the leads to the heater element before it can be removed.

WARNING: Do not tamper with the heater thermal operated switch. The screw that extends through one end of the switch assembly is the adjusting screw. Rotating the screw one revolution will change the temperature at which the switch will operate by approximately 30° F. (Refer to 6.14 **THERMAL SWITCH ADJUSTMENT.**)

In reassembling it is important to see that the tuning slug guide arm spring fits snugly on the steel spacer rod. Take care that the asbestos sheet that is part of the heater assembly (or any small particles thereof) does not remain between the heater assembly and the bearing plates. Leave one pair of coupler set screws loose until the unit is recalibrated.

Recalibrate the master oscillator while the unit is still on the bench. Connect the exciter to the transmitter power and control circuits with the test cables and apply filament and plate voltages. Rotate the OSCILLATOR TUNING knob until the Multiturn Unit dial indicates "20" (approach the setting clockwise through at least one-eighth revolution). Using a frequency standard, adjust the master oscillator to a frequency of 1000 kc and tighten the two remaining coupler set screws. Refer to **Master Oscillator Calibration** in this section of the book. Replace the exciter unit bottom shield and replace the exciter unit in the cabinet.

If it becomes necessary to remove the entire oscillator assembly, the following procedure is recommended:

a. Remove the r-f exciter unit from the transmitter and remove the bottom shield and the Autotune cover from the unit.

b. Heat the solder that holds C173 to the mounting screw and remove the screw.

c. Disconnect the bus lead that comes out of the master oscillator annex directly under C173 where the lead connects to the tube socket. Disconnect the leads that are attached to the terminal blocks on the master oscillator and the master oscillator annex.

d. Remove the master oscillator tube shield, disconnect the grid cap and remove the oscillator tube (Type 6A8) from the socket.

e. Loosen the two screws that secure the flexible coupler to the Autotune shaft.

f. Remove the three short screws that attach the back plate of the Multiturn unit to the Autotune Casting. Remove the Multiturn unit. **Caution:** Care must be exercised not to move any of the Autotune mechanism from the time the unit is loosened until the unit is again securely in place. If the shafts are moved the Autotune mechanism may be thrown out of synchronization.

g. Remove the short screw that is located on top of the chassis just behind the master oscillator tube shield. Loosen the two long screws that secure the master oscillator unit to the Autotune casting. (The heads of these screws are exposed by the removal of the Multiturn unit.)

h. The master oscillator unit with the master oscillator annex attached may now be lifted out of the exciter chassis. For further disassembly of this unit follow the procedure that was outlined in the first part of this section, 6.13.

6.14. THERMAL SWITCH ADJUSTMENT. A thermal operated switch is employed in this equipment to control the master oscillator compartment heater. The oscillator compartment heater switch, S110, should be adjusted to operate when the temperature within the compartment is between 65°C and 70°C.

The adjustment procedure is outlined below:

(a.) Obtain a pan or earthenware bowl of water, a source of heat (electric plate, gas burner, etc.) an accurate thermometer (preferably graduated in degrees C.), a lamp, batteries or other source of voltage to operate the lamp and a supply of hook-up wire.

(b.) Connect the switch, pilot lamp and voltage source in series. The lamp should light. The switch is normally closed.

(c.) Place the switch in the cool water.

(d.) Place the thermometer in the water near the switch.

(e.) Place the container of water over the source of heat.

(f.) Raise the temperature of the water slowly.

(g.) Watch the thermometer and pilot lamp and carefully note the temperature of the water at the time that the circuit is broken.

(h.) Record the temperature at which the switch operated, cool the water and repeat Steps c. thru g. until three trials have been made.

To change the temperature at which the switch will operate rotate the adjusting screw that protrudes from the end of the switch assembly. **Rotate the adjusting screw in a counterclockwise direction to raise the temperature reading at which the switch will operate.** Rotating the screw one revolution changes the adjustment so that the switch will operate at a temperature approximately 15°C higher or lower than the temperature at which it originally operated.

(i.) Calculate the number of revolutions or fraction of a revolution that it will be necessary to rotate the adjusting screw to obtain switch operation in the proper temperature range (between 65°C and 70°C).

(j.) Repeat the checking and adjustment procedure until the switch operates consistently within the proper temperature range.

VII DATA

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7.1. TRANSMITTER DATA

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7.2. COLOR CODES

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Capacitor Code 135

Resistor Code 135

7.1. TRANSMITTER DATA.

7.1.1. Power Input Requirements.

Conditions	Watts	Power Factor
1. Dial A0	155	0.945
2. Filaments On—CW	1105	0.847
3. Filaments On—MCW or VOICE	1385	0.888
4. Filaments and Plate On (Standby)—CW	1840	0.870
5. Filaments and Plate On (Standby)—MCW or VOICE	3160	0.930
6. Carrier On—CW	6480	0.956
7. Carrier On—MCW or VOICE (No Mod.)	7240	0.960
8. Carrier On—MCW or VOICE (100% Mod.)	9920	0.956

7.1.2. Radio Frequency.

(a) **Frequency Coverage.**

1. EXCITER BAND SWITCH

Position	Frequency Range (Mc)
1	9.0 to 18.1
2	6.0 to 9.0
3	3.0 to 6.0
4	2.0 to 3.0

2. INT. AMP. BAND SWITCH

Position	Frequency Range (Mc)
1	15.0 to 18.1
2	12.5 to 15.0
3	10.5 to 12.5
4	8.0 to 10.5
5	6.5 to 8.0
6	5.0 to 6.5
7	4.0 to 5.0
8	3.2 to 4.0
9	2.5 to 3.2
10	2.0 to 2.5

3. POWER AMP. BAND SWITCH

Position	Frequency Range (Mc)
1	16.5 to 18.1
2	14.0 to 16.5
3	11.0 to 14.0
4	7.8 to 11.0
5	5.4 to 7.8
6	3.5 to 5.4
7	3.0 to 3.5
8	2.6 to 3.0
9	2.2 to 2.6
10	2.0 to 2.2

Note: The above coverage measurements were made using a 300 ohm dummy antenna load.

(b) **Frequency Deviation.**

Operation	Freq. Change (%)
1. Detuning Exciter	0.00066
2. Changing Oscillator Tubes	0.02000
3. Changing Voltage Regulator Tubes	0.00100
4. Detuning Power Amplifier	None
5. Change Line Voltage ±10% in 1 minute	None
6. Operating Power Level Switch from L.V. to TUNE	0.00015
7. Operating Power Level Switch from TUNE to OP.	0.00015

(c) **Frequency Stability.**

1. Frequency vs. Temperature

Temperature Change (Degrees)	Freq. Change (%)
0 - 10	0.0005
10 - 20	0.0003
20 - 30	0.0016
30 - 40	0.0004
40 - 50	0.0001

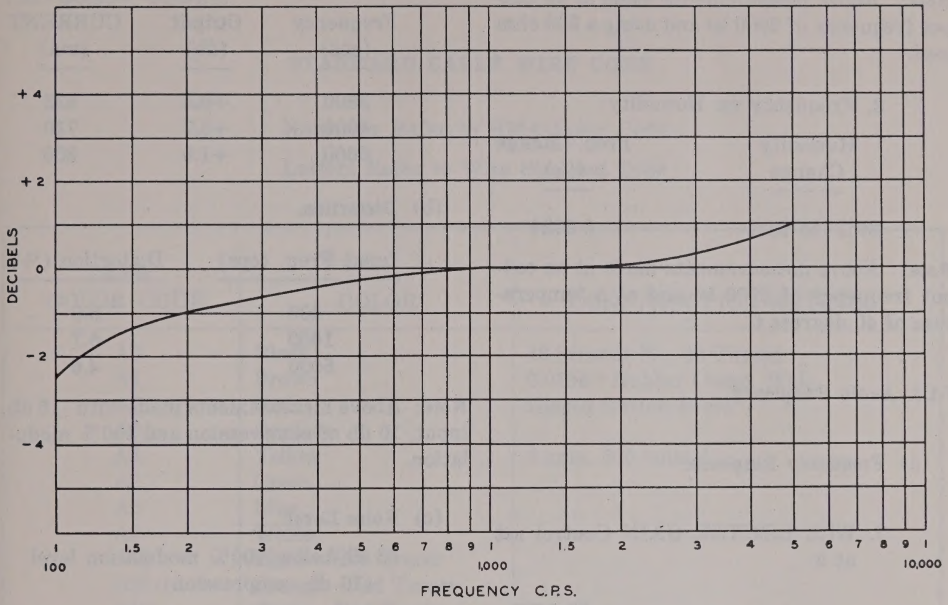


Fig. 47 Frequency Response Curve (Dwg. No. 502 1211 002)

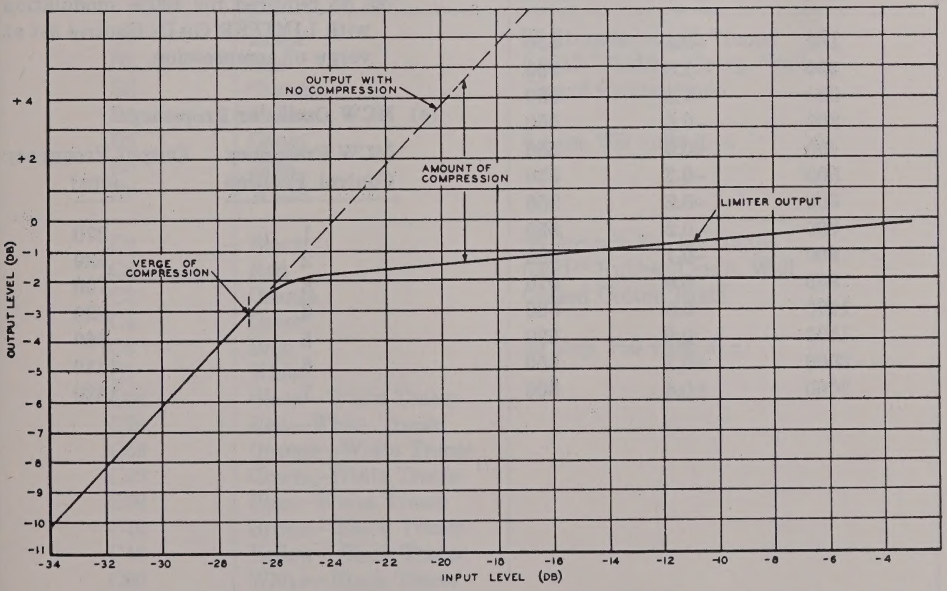


Fig. 48 Limiter Curve (Dwg. No. 1632C)

Note: Above measurements made at an output frequency of 2000 kc and using a 300 ohm load.

2. Frequency vs. Humidity

Humidity Change	Freq. Change (%)
30% to 95%	0.0026

Note: Above measurements made at an output frequency of 2000 kc and at a temperature of 40 degrees C.

7.1.3. Audio Frequency.

(a) **Frequency Response.**

1. With LIMITER GAIN Control set at 0.

Frequency (cps)	Output (db)	PLATE CURRENT (ma)
100	–2.5	550
150	–1.3	550
200	–1.1	550
300	–0.6	550
400	–0.5	550
500	–0.3	550
600	–0.2	555
700	–0.2	555
800	–0.1	555
900	0.0	570
1000	0.0	580
1500	0.0	590
2000	+0.1	600
3000	+0.4	600
3500	+0.4	635
4000	+0.7	710
5000	+1.0	800

(b) **Distortion.**

Input Freq. (cps)	Distortion (%)
400	8.0
1000	6.7
5000	4.6

Note: Above measurements made with -15 db input, 10 db of compression and 100% modulation.

(c) **Noise Level.**

53 db below 100% modulation level (10 db compression).

(d) **Audio Input.**

-25 db required for 100% modulation with LIMITER GAIN Control set at verge of compression.

(e) **MCW Oscillator Frequency.**

MCW Frequency Control Position	Output Frequency (cps)
1	370
2	530
3	700
4	830
5	960
6	1110
7	1320

7.2. COLOR CODES.

STANDARD CABLE WIRE CODE

Numerals Refer to RMA Color Code
Letters Refer to Wire Size and Type

NEW COLOR CODE	COLOR	CONSTRUCTION RATINGS
A0	Black	16 Strands No. 30 Tinned
A1	Brown	0.0156″ Rubber Comp. Wall
A2	Red	Glazed Cotton Braid
A3	Orange	
A4	Yellow	3 amp. 500 volts d. c.
A5	Green	
A6	Blue	
A9	White	
A02	Black—Red Tracer	
A32	Orange—Red Tracer	
A52	Green—Red Tracer	
A62	Blue—Red Tracer	
A92	White—Red Tracer	
B0	Black	26 Strands No. 30 Tinned
B2	Red	0.0313″ Rubber Comp. Wall
B3	Orange	Glazed Cotton Braid
B4	Yellow	
B5	Green	6 amp. 750 volts d. c.
B6	Blue	
B9	White	
C0	Black	65 Strands No. 30 Tinned
C2	Red	0.031″ Rubber Comp. Wall
C3	Orange	Glazed Cotton Braid
C5	Green	
C6	Blue	20 amp. 750 volts d. c.
C9	White	
C09	Black—White Tracer	
C29	Red—White Tracer	
C39	Orange—White Tracer	
C59	Green—White Tracer	
C69	Blue—White Tracer	
C10	Brown—Black Tracer	
C40	Yellow—Black Tracer	
C90	White—Black Tracer	

STANDARD CABLE WIRE CODE

NEW COLOR CODE	COLOR	CONSTRUCTION RATINGS
D0	Black	19 Strands No. 27 Tinned 3/64″ Live Rubber Wall Lacquered Double Braid—5KV
E0	Black	7 Strands No. 30 Tinned 0.01″ Unvulcanized Rubber Wall Glazed Cotton Braid 1.5 amp. 300 volts d. c.
E2	Red	
E3	Orange	
E5	Green	
E6	Blue	
E9	White	
E03	Black—Orange Tracer	
E23	Red—Orange Tracer	
E53	Green—Orange Tracer	
E63	Blue—Orange Tracer	
E93	White—Orange Tracer	
E05	Black—Green Tracer	
E25	Red—Green Tracer	
E35	Orange—Green Tracer	
E95	White—Green Tracer	
E06	Black—Blue Tracer	
E26	Red—Blue Tracer	
E36	Orange—Blue Tracer	
E96	White—Blue Tracer	
K0	Black	10 Strands No. 30 Tinned 0.0156″ Rubber Comp. Wall Glazed Cotton Braid Tinned Copper Braid Shielding 3 amp. 300 volts d. c.
K2	Red	
K3	Orange	
K5	Green	
K6	Blue	
N0	Black	16 Strands No. 30 AWG Felted Asbestos Wall Overall Cotton Braid Nominal diameter 0.135″ Rated at 6-10 amps 300 volts
BB10	Tinned	1 Strand No. 10 AWG. Tinned 30 Amps.
BB12	Tinned	1 Strand No. 12 AWG. Tinned 25 Amps.
BB14	Tinned	1 Strand No. 14 AWG. Tinned 20 Amps.
BB16	Tinned	1 Strand No. 16 AWG. Tinned 10 Amps.

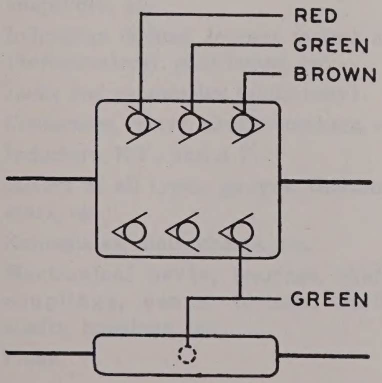
CAPACITOR COLOR CODE

The Standard RMA Color Code is used to indicate the capacity of some of the midget mica capacitors used in the equipment. The colors and corresponding numbers are listed below:

0—Black
1—Brown
2—Red
3—Orange
4—Yellow
5—Green
6—Blue
7—Violet
8—Gray
9—White

Three colored dots, with arrows indicating the sequence of colors indicate the capacity. The third dot of color indicates the number of zeros following the first two figures. All capacity values are in micromicrofarads (mmfd). The tolerance in per cent is indicated by the spot of color on the edge of the capacitor.

For example, the capacitor shown below has a capacity of 250 mmfd (0.00025 mfd). The color sequence is red (2), green (5) and brown (1). The tolerance is ±5% as indicated by the spot of green on the edge or the color of the fourth dot on the top of the capacitor.



Dwg. No. 500 0246 00A

RESISTOR COLOR CODE

The Standard RMA Color Code is used to indicate the resistance of the small resistors used in the equipment. The colors and corresponding numbers are listed below:

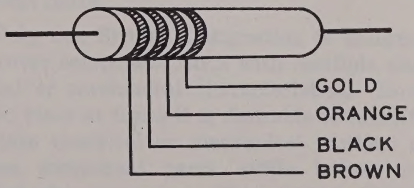
0—Black
1—Brown
2—Red
3—Orange
4—Yellow
5—Green
6—Blue
7—Violet
8—Gray
9—White

The resistors are marked with three colored "bands" near one end. All resistance values are in ohms. The color sequence begins with the color nearest the end of the resistor. The first "band" indicates the first number of the sequence, the second "band" the second number and the third "band" the number of zeros following the second number.

Tolerance values for the resistors are designated by the fourth "band" on the resistor body using the following colors to indicate the percentage of tolerance:

1%—Brown
2%—Red
3%—Orange
4%—Yellow
5%—Green
or Gold
6%—Blue
7%—Violet
8%—Gray
9%—White
10%—Silver

For example, the resistor shown below has a resistance of 10,000 ohms and a tolerance of ±5%. Brown (1), black (0), orange (3), and gold (5).



Dwg. No. 500 0242 00A

VIII APPENDIX

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APPENDIX

PARTS LISTS

Component parts of the equipment are identified by means of symbol designations. Wherever it is required to reference a component, the same symbol designation is used. Thus, a part appearing on a simplified schematic, a complete circuit diagram, a wiring diagram, photograph or layout drawing, will always be identified by means of the same symbol designation. In addition, each component part is stamped with its corresponding symbol designation. These symbol designations identify the various component parts which appear in the following parts lists. No symbol designation is used to identify more than one part.

The alphabetical portion of symbol designations have been selected from the following list in accordance with the classification of the component parts concerned.

(A) Structural parts, panels, frames, castings, etc.
(B) Motors and other prime movers, self-synchronous motors, etc.
(C) Capacitors of all types.
(D) Dynamotors.
(E) Miscellaneous electrical parts: insulators, knobs, brushes, etc.
(F) Fuses.
(G) Generators, exciters, etc.
(H) Hardware, screws, bolts, studs, pins, snapslides, etc.
(I) Indicating devices (except meters and thermometers), pilot lamps, etc.
(J) Jacks and receptacles (stationary).
(K) Contactors, relays, circuit breakers, etc.
(L) Inductors, R.F., and A.F.
(M) Meters of all types, gauges, thermometers, etc.
(N) Nameplates, dials, charts, etc.
(O) Mechanical parts, bearings, shafts, couplings, gears, ferrules, flexible shafts, housings, etc.
(P) Plugs.
(Q) Diaphragms, (microphone, telephone, projector, etc.).
(R) Resistors, fixed and variable, potentiometers, etc.
(S) Switches, interlocks, thermostats.
(T) Transformers, R.F., and A.F., and power.
(U) Hydraulic parts.
(V) Vacuum and gaseous discharge tubes.
(W) Wires, interconnecting cables, without plugs.
(X) Sockets.
(Y) Mechanical oscillators, crystals, magnetestriction tubes, etc.
(Z) Filters, IF transformers, compound tuned circuit assemblies, etc., in a common container.
(CR) Dry Disk Rectifiers.
(HS) Handsets.

The numerical portion of the Symbol Designation has been assigned to identify the component part with a particular major unit assembly. The numerical portion of symbol designations begin with 101 for the first component part in each class (i.e., component part in each alphabetical class as described above) and run consecutively for the remaining component parts in a particular class. A different numerical series of numbers is used for each major unit of the equipment. The series 101 to 199 is reserved for the first major unit. The series 201 to 299 is reserved for the second major unit. The series 301 to 399 is reserved for the third major unit. In this manner, each major unit of the entire equipment is identified with a series of numerals to be used for the designation of component parts.

Only one Symbol Designation is assigned to cover component parts with multiple electrical or mechanical characteristics. However, since at times it is desirable to identify certain electrical or mechanical sections of these component parts, suffix letters are added when necessary. Thus, C121A, C121B, and C121C identify each section of triple capacitor C121.

PARTS LIST BY SYMBOL DESIGNATION

MOTORS

Symbol Desig-nation	Function	Description	Navy Type Desig-nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
B101	Autotune Motor	1/3 h. p. 230 v 50/60 cps 3 phase 1/4 h.p. 230 v 50/60 cps 3 phase			1390	1177192C		232 0003 00 232 0004 00
B301	Ventilating Blower	1/3 h. p. 230 v 50/60 cps 1 phase 1140 rpm Direct Connected			1881			9N221
		CAPACITORS						
C101	Cap., V114 Fil. Bypass	Mica 6000 mmf ±20% 1000 TV			911 4030 4210	9L A2-10 XMB		906N260A-M
C102	Cap., V114 Fil. Bypass	Same as C101						
C103	Cap., V115 Fil. Bypass	Same as C101						
C104	Cap., V115 Fil. Bypass	Same as C101						
C105	Cap., Int. Amp. Plate Tuning	Dual Var. Air, 250 mmf max.			2140	Type TCD		920N37A
C106	Cap., Grid Circuit Balancing	56 mmf .171" spacing			830	GA-1734B		GA-1734B
C107	Cap., Pwr. Amp. Bias Filter	Mica, 0.002 mf ±20% 6000 TV (9, 6, 4, 2) Low Loss Case			911	Type 6		906N220H-M
C108	Cap., Int. Amp. Feedback Coupl.	Same as C107						
C109	Cap., Int. Amp. Plate Supply Bypass	Same as C107						
C110	Cap., Int. Amp. Output Coupling	Same as C107						
C111	Cap., V101 Anode Tank	Ceramic .0023 mf ±5% Coeff. Neg. 40 ppm/°C. ±5 ppm/°C.			700			913 0006 00
C112	Cap., V101 Anode Tank	Ceramic .0002 mf ±2½% 1000 TV			700	814		913 0004 00
C113	Cap., V101 Tank Coupling	.001 mf ±5% Coeff. Neg. 750 ppm/°C. ±15% per °C.			700			913 0007 00
C114	C114A, C114B, C114C	0.1/0.1/0.1 mf Foil Paper ±20% 600 WV D. C.			911 4210 4250	 2527-8		956NT01W-M
C114A	Cap., V101 Anode Supply Bypass	Section of C114						

PARTS LIST BY SYMBOL DESIGNATION

CAPACITORS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
C114B	Cap., V101 Grid Bypass	Section of C114						
C114C	Cap., V101 Screen Decoupl.	Section of C114						
C115	C115A, C115B, C115C	Same as C114						
C115A	Cap., V101 Cathode Bypass	Section of C115						
C115B	Cap., V101 Fil. Bypass	Section of C115						
C115C	Cap., V101 Fil. Bypass	Section of C115						
C117	Cap., Int. Amp. Neut.	Adj. Plate			830	YA-1771B		1771B
C118	C118A, C118B	Foil Paper, 0.1/0.1 mf ±20% 600 WV			911 4250 2330			956ND01W-M
C118A	Cap., V101 Plate Supply Filter	Section of C118						
C118B	Cap., V102 Scr. Supply Bypass	Section of C118						
C119	Cap., V101 Output Coupling	Mica 0.006 mf ±20% 1500 TV Low Loss			4030	Type BE-15		915N260E-M
C120	C120A, C120B	Same as C118						
C120A	Cap., V102 Cathode Bypass	Section of C120						
C120B	Cap., V102 Screen Decoupl.	Section of C120						
C121	Cap., V103 Grid Bias Filter	Foil paper, 0.1 mf ±20% 600 WV			911			956NS01W-M
C122	Cap., V104 Plate Supply Filter	Same as C121						
C123	Cap., V102 Output Coupling	Mica 0.001 mf ±20% 1500 TV Low Loss			4030	Type BE-15		915N210E-M
C124	Cap., V103 Cathode Bypass	Single Sect. Foil Paper 0.1 mf ±20% 600 WV			4250 911 4210			956NS01Y-M
C125	Cap., V103 Screen Decoupl.	Same as C119						
C126	Cap., V103 Output Coupling	Same as C123						
C127	Cap., V103 Plate Tank Tuning	Variable 300 mmf max. 15 mmf min. single sect.			2570	E		920N116
C128	Cap., V104 Grid Coupling	Same as C123						
C129	Cap., V104 Cathode Bypass	Same as C124						

PARTS LIST BY SYMBOL DESIGNATION

CAPACITORS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
C130	Cap., V104 Screen Decoupling	Same as C119						
C131	Cap., V104 H. V. Blocking	Same as C123						
C132	Cap., V104 Plate Tank Tuning	Same as C127						
C133	Cap., Int. Amp. Low Voltage Isolating	Same as C123						
C134	Cap., Int. Amp. Fil. Bypass	Mica 0.01 mf ±20% 1000 TV Low Loss Case			911 4030 4210	9L		910N110A-M
C135	Cap., Int. Amp. Fil. Bypass	Same as C134						
C136	Cap., Int. Amp. Screen Decoupling	Same as C134						
C137	Cap., V109 Grid Decoupling	Same as C123						
C138	Cap., V103 Plate Tank Trimming	Midget Variable 44 mmf max. 7 mmf min.			4170	ATR		922N32
C139	Cap., V111 Grid Coupling	Same as C123						
C140	Cap., CFI Input Coupling	Silvered Mica .001 mf ±20% 500 TV Low Loss Case			911	2RS		912N210H-M
C141	Cap., V110 Plate Decoupling	Same as C123						
C142	Cap., V111 Grid Coupling	Same as C119						
C143	Cap., V111 Grid Coupling	Same as C119						
C144	Cap., V110 Cathode Coupling	.00025 mf ±20% 1500 TV			4030			915N325E-M
C145	Cap., V110 Grid Coupling	Same as C119						
C146	C146A, C146B, and C146C	Same as C114						
C146A	Cap., V111 Screen Decoupling	Section of C146						
C146B	Cap., V111 Plate Supply Filter	Section of C146						
C146C	Cap., V110 Plate Supply Filter	Section of C146						
C147	Cap., V113 Grid Coupling	Foil Paper .02 mf ±20% 600 WV			911 4210 4250			956NS14W-M
C148	Cap., CFI Plate Supply Filter	Paper 0.5 mf ±20% 600 WV D. C.			911	DYRT		956NS08W-M
C149	Cap., V113 Grid Coupling	Same as C147						

PARTS LIST BY SYMBOL DESIGNATION

CAPACITORS (Cont.)

Symbol Desig-nation	Function	Description	Navy Type Desig-nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
C150	Cap., Meter Bypass	Mica 0.001 mf ±20% 1000 TV D.C.			911			910N210D-M
C151	Cap., Meter Bypass	Same as C150						
C152	Cap., Meter Bypass	Same as C150						
C153	Cap., Meter Bypass	Same as C150						
C154	Cap., P. A. H-V Filter	Mica 2000 mmf ±20% 10,000 TV 60 cycles rms			911	50		900N220-M
C155	Cap., P. A. Plate Blocking	Fixed Air dielectric Approx. 0.002 mf			830	GA-500 1304 00B		500 1304 00B
C157	Cap., P. A. Neutralizing	Semi-variable disc air dielectric			830	GA-1652C		GA-1652C
C158	Cap., P. A. Plate Tank Tuning	Min. 30 mmf Max. 140 mmf per			830	GA-1173C		GA-1173C
		section. Stator, Rotor			830	GB-565D		GB-565D
C159	Cap., P. A. Loading	Variable Air dielectiric 40 min.						
		840 max. mmf per section Stator			830	GA-1175C		GA-1175C
		Rotor			830	GB-566D		GB-566D
C163	Cap., Spark Suppressing	Paper 0.25 mf ±20% 600 WV			911			956NS05W-M
C164	C164A, C164B, C164C	Paper 4/4/4 mf ±20% 600 WV			911	KC-6		956NT7J-M
C164A	Cap., Relay Voltage Filter	Section of C164						
C164B	Cap., Relay Voltage Filter	Section of C164						
C164C	Cap., Relay Voltage Filter	Section of C164						
C165	Cap., Transient Suppr.	Paper 0.25 mf ±20% 600 WV			911	DYR		956NS05Y-M
					4210	XDMR		
C166	Cap., H-V Filter	Paper 4.0 mf ±20% 7500 WV			911	TK-70040		930N91-M
C167	Cap., Int. Voltage Filter	Paper 4 mf ±20% 4000 WV			911	TJ-40040A		930N45A-M
C168	Cap., V113 Output Matching	Same as C119						
C169	Cap., V102 Plate Supply Filter	Same as C119						
C170	Cap., V101 Plate Supply Filter	Same as C119						
C171	Cap., V101 & V102 Fil. Supply Filter	Same as C119						
C172	Cap., V109 Plate Bypass	Same as C119						
C173	Cap., CFI Input Voltage Dividing	4 to 6 mmf Special			830			500 1463 00B
C174	Cap., CFI Input Voltage Div.	Approx. 50 mmf shielded wire						
C175	Cap., V116 Filament Bypass	Same as C123						
C176	Cap., V116 Filament Bypass	Same as C123						

PARTS LIST BY SYMBOL DESIGNATION

CAPACITORS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
C177	Cap., Int. Amp. Grid Coupling	.0001 mf ±20% 1500 TV			4030	BE-15		915N310E-M
C178	Cap., Int. Amp. Grid Coupling	Same as C123						
C202	Cap., L. V. Supply Filter	Same as C164						
C203	Cap., L. V. Supply Filter	Same as C164						
C204	Cap., Bias Supply Filter	Same as C164						
C205	Cap., Bias Supply Filter	Same as C164						
C301	C301A, C301B, C301C	Same as C164						
C301A	Cap., Audio Input Coupling	Section of C301						
C301B	Cap., V301 Cathode Bypass	Section of C301						
C301C	Cap., Plate Voltage Filter	Section of C301						
C302	Cap., V305 Plate Coupling	Paper 0.25 mf ±20% 600 WV			911			956NS05V-M
C303	Cap., V305 Grid Coupling	Paper 0.1 mf ±20% 600 WV			911 3125			956NS01V-M
C304	Cap., V305 Cathode Coupling	Same as C303						
C305	Cap., V303 Cathode Bypass	Paper 0.5 mf ±20% 600 WV			911 4210	DYRB XDMB		956NS08V-M
C306	Cap., V302 Grid Bypass	Same as C302						
C307	Cap., V307 Grid Coupling	Same as C302						
C308	Cap., V308 Grid Coupling	Same as C302						
C309	C309A, C309B, C309C	Same as C164						
C309A	Cap., V304 Cathode Bypass	Section of C309						
C309B	Cap., V304 Plate Decoupling	Section of C309						
C309C	Cap., Plate Voltage Filter	Section of C309						
C310	Cap., MCW Osc. Tank	Paper 0.22 mf, 0.3 mf, 0.4 mf, 0.55 mf, 0.82 mf, 1.4 mf, 2.8 mf ±10% 600 WV			911			956NM1-K
C311	Cap., Audio Driver Cathode Bypass	Paper 4 mf ±20% 600 WV			911	TJ-6040		930N30A-M
C312	Cap., Mod. Grid Bypass	Same as C311						
C313	Cap., Meter Bypass	Same as C150						
C314	Cap., Meter Bypass	Same as C150						
C315	Cap., Meter Bypass	Same as C150						

PARTS LIST BY SYMBOL DESIGNATION

CAPACITORS (Cont.)

Symbol Desig-nation	Function	Description	Navy Type Desig-nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
C401	Cap., V401 Cathode Bypass	Same as C160						
C402	Cap., V402 Grid Coupling	Same as C303						
C403	C403A, C403B, C403C	Same as C164						
C403A	Cap., V401 Screen Supply Filter	Section of C403						
C403B	Cap., V402 Cathode Bypass	Section of C403						
C403C	Cap., V402 Plate Decoupling	Section of C403						
C404	Cap., V401 Screen Decoupling	Same as C121						
C405	C405A, C405B, C405C	Same as C164						
C405A	Cap., Audio Input Coupling	Section of C405						
C405B	Cap., H. V. Supply Filter	Section of C405						
C405C	Cap., H. V. Supply Filter	Section of C405						
C406	C406A, C406B, C406C	Same as C164						
C406A	Cap., H. V. Supply Filter	Section of C406						
C406B	Cap., H. V. Supply Filter	Section of C406						
C406C	Cap., H. V. Supply Filter	Section of C406						

DRY DISC RECTIFIERS

Symbol Desig-nation	Function	Description	Navy Type Desig-nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
CR201	Relay Supply Rectifier	Output: 48 v d. c. at 0.52 amp Continuous, Input: 70 v 60 cps			380	1E0B551		353N26

MISCELLANEOUS ELECTRICAL PARTS

Symbol Desig-nation	Function	Description	Navy Type Desig-nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
E102	V104 Grid Parasitic Suppr.	Spec. h-f parasitic suppressor			830	GA-1064A		GA-1064A
E103	P. A. Fil. Conn. Strip	4 term. black bakelite conn. strip 5/16″ x 10-32 screws			2580	150		367N704
E104	M. O. Terminal Strip	4 term. conn. strip			2580	4-140		367 0002 00
E105	P. A. Fil. Supply Term. Strip	11 term. black bakelite conn. strip 5/16″ x 8-32 screws			2580	142		367N511

PARTS LIST BY SYMBOL DESIGNATION

MISCELLANEOUS ELECTRICAL PARTS (Cont.)

Symbol Desig- nation	Function	Description	Navy Type Desig- nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig- nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
E106	P. A. Fil. Supply Term. Strip	Same as E103						
E107	M. O. Heater Terminal Strip	2 term. conn. strip			2580	2-140		367 0001 00
E108	P. A. Stabilizer Term. Strip	5 term. black bakelite conn. strip 3/16'' x 6-32 screws			2580	142		367N505
E109	Antenna Ammeter Ass'y Feedthru	½'' x 1'' Ceramic tapped 8/32			2410	323-L1		190NSL1
E110	Ant. & Ground Cabinet Feedthru Assembly	2½'' Pyrex bowl assembly			920	67104		192N204
E111	Standoffs for R167	1⅝'' x 1'' x ¾'' Ceramic block			60			193N1
E112	Standoffs for C157	3'' x 1½'' Conical Ceramic tapped 10/32			2410	435-L3		190NSN3
E113	Standoffs for L122	1¼'' x ½'' Cylindrical ceramic tapped 6/32			700			190NSL23
E114	Standoffs for L126	Same as E113						
E115	S111 Contact Standoff	Special Ceramic Standoff 2.6'' x .875'' tapped 6/32			700	X-513		190NSL24
E116	C158 Stator Mtg. Bar	¼'' x 5⅛'' x 1½'' Mycalex Bar			830			YA-1672B
E117	C159 Stator Mtg. Bar	Same as E116						
E118	C158 Stator Mtg. Bar	9⅝'' x 1½'' x ⅜'' Mycalex Bar			830			YA-1671B
E119	C159 Stator Mtg. Bar	Same as E118						
E120	Standoffs for L125	2'' x 1⅛'' Conical Ceramic tapped 10/32			2410	434-L2		190NSN2
E121	Standoffs for L128	Same as E120						
E122	Standoffs for S116	2'' x ½'' Cylindrical Ceramic tapped 8/32			2410	323-L2		190NSL2
E123	Standoffs for S112	Same as E122						
E124	Standoffs for L101	Same as E113						
E125	Standoffs for L102	Same as E113						
E126	Standoffs for R174	2⅜'' x 2¼'' x 1¼'' Ceramic block			60			193N2
E127	Standoff for C108	Same as E111						
E128	Standoff for C109	Same as E111						
E129	Standoff for C107	Same as E111						

PARTS LIST BY SYMBOL DESIGNATION

MISCELLANEOUS ELECTRICAL PARTS (Cont.)

Symbol Desig-nation	Function	Description	Navy Type Desig-nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
E130	Standoff for C110	1¾″ x ½″ Cylindrical Ceramic tapped 8/32			2410 4320	323L1-¾ SL6450-352		190NSL22
E131	Pwr. Amp. Bias Feedthru Assembly	3½″ x 1¼″ Overall			920	45		190NF114
E132	Int. Amp. Plate Supply Feedthru Assembly	Same as E131						
E133	Standoff for L134	1¼″ x ½″ Cylindrical Ceramic tapped 8/32			2410	323-L1-¼		190NSL4
E134	Standoff for L135	1″ x ⅜″ Cylindrical Ceramic tapped 6/32			2410			190NSL15
E135	Standoff for X116	Same as E130						
E136	Standoff for C106	Same as E133						
E137	Standoff for R111	Same as E111						
E138	Standoff for R115	Same as E111						
E139	Standoff for R124	Same as E111						
E140	Standoff for R127	Same as E111						
E141	Standoff for R161	Same as E111						
E142	Standoff for R162	Same as E111						
E143	Feedthru for V101 Plate Lead	⅜″ x ⅝″ Bushing Recpt.			2410	979A		190NB119
E144	Feedthru for V101 Plate Lead	⅜″ x ⅝″ Bushing Plug			2410			190NB120
E201	Power Unit Terminal Strip	13 term. black bakelite conn. strip 3/16″ x 6-32 screws			2580	141		367N413
E202	Power Unit Terminal Strip	14 Term. Bakelite Conn. strip 5/16″ x 8-32 screws			2580	142		367N514
E203	Power Unit Terminal Strip	Same as E201						
E204	Power Unit Terminal Strip	Same as E202						
E205	H. V. Rect. Plate Lead Feedthru Assembly	5¾″ x 1⅝″ Ceramic Bushing Assembly			920	46		190NFI4
E206	H. V. Rect. Plate Lead Feedthrus	Rear section of E205						
E301	Remote Connections Term. Strip	7 Term. Black Bakelite Conn. Strip 3/16″ x 6-32 Screws			2580	141		367N407

PARTS LIST BY SYMBOL DESIGNATION

MISCELLANEOUS ELECTRICAL PARTS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
E302	Blower Connector Strip	2 Term. Black Bakelite Conn. Strip 6-32 x ¼			2580	240		367N402
E303	Standoffs for R331	Same as E126						
E304	Modulator Plate Lead Standoffs	2″ x 1⅛″ Conical Ceramic tapped 10/32			2410	434-L2		190NSN2
E305	Standoffs for F304	Same as E126						
E306	Blower Motor Shockmounts	Large			830	GA-2605A		GA-2605A
		Medium			830	GA-2606A		GA-2606A
		Small			830	GA-2607A		GA-2607A
E307	Modulator Grid Lead Feedthrus	Same as E131						
E308	Standoff for R323	Same as E111						
E309	Standoff for X309	Same as E133						
E310	Standoff for X310	Same as E133						
E311	Standoff for X311	Same as E133						
E312	Standoff for X312	Same as E133						
E313	Standoff for C311	Same as E111						
E401	Control Unit Terminal Strip	14 Term. Black Bakelite Conn. Strip			2580	240		367N614
		FUSES						
F101	Fuse, M. O. Heater	⅜ amp 250 v 4 ohm average resistance 1¼ x ¼ cartridge Slo Blo			2920	3AG		264N425
F102	Fuse, Exc. Fil. Primary	¼ amp 250 v average resistance 8 ohm 1¼ x ¼ cartridge Slo Blo			2920	3AG		264N424
F103	Fuse, Int. Amp. Fil. Pri.	¾ amp 250 v average resistance 1 ohm 1¼ x ¼ cartridge Slo Blo			2920	3AG		264N427
F104	Fuse, Autotune Motor	8 amp 250 v 1¼ x ¼ cartridge			2920	3AG		264N411
F105	Fuse, Autotune Motor	Same as F104						
F106	Fuse, Autotune Motor	Same as F104						
F107	Fuse, P. A. Fil. Primary	2 amp 250 v 1¼ x ¼ cartridge			2920	3AG		264N407
F108	Fuse, P. A. Fil. Primary	Same as F107						
F109	Fuse, V116 Fil. Pri.	Same as F102						

PARTS LIST BY SYMBOL DESIGNATION

FUSES (Cont.)

Symbol Desig- nation	Function	Description	Navy Type Desig- nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig- nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
F201	Fuse, H. V. Rect. Fil. Pri.	3 amp 250 v 1¼ x ¼ cartridge			2920 530	3AG 3AG		264N408
F202	Fuse, H. V. Rect. Fil. Pri.	Same as F201						
F203	Fuse, Relay Rect. Supply Primary	Same as F107						
F204	Fuse, L. V. Rect. Plate Pri.	Same as F201						
F205	Fuse, Bias Rect. Plate Pri.	Same as F201						
F206	Fuse, L. V. Rect. Fil. Pri.	1 amp 250 v 1¼ x ¼ cartridge			2920 530	3AG 3AG		264N405
F207	Fuse, Bias Rect. Fil. Pri.	Same as F206						
F208	Fuse, Relay Supply Output	Same as F201						
F301	Fuse, Mod. Fil. Pri.	1 amp 250 v 1¼ x ¼ cartridge Slo-Blo			2920	3AG		264N428
F302	Fuse, Speech Amp. Fil. Pri.	Same as F101						
F303	Fuse, Audio Driver Fil. Pri.	Same as F101						
F304	Fuse, Mod. Plate Supply	2 amp 5000 v 5″ x 13/16″ cartridge			2920	3026		264N819
F401	Fuse, Power Input	Same as F102						
		HANDSETS						
HS301	Local Control Handset	Output—14.5 db transmitter resistance 24 ohms, 200 ma. max. receiver impedance 128 ohms			4870	F-3AW-3		977N18
		LAMPS						
I201	FILAMENT Pilot Lamp	110 v 55 ma 6 w Candelabra Base			1881	T-4½		262N333
I202	PLATE Pilot Lamp	Same as I201						
I401	Pilot Lamp	6.3 v 0.15 amp Miniature Bayonet Base			1881 3846	47 R40A		262N324

PARTS LIST BY SYMBOL DESIGNATION

JACKS AND RECEPTACLES

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
J101	Receptacle for Autotune Control Unit Conn Plug P101	17 Term. Conn. Jack			830	AC103B		AC103B
J102	Receptacle for Autotune Control Unit Conn. Plug P102	19 Term. Conn. Jack			830	AC104A		AC104A
J103	CFI Unit Conn. Plug Receptacle	6 Term. Conn. Socket Chassis Mtg.			2580	SS-6-AB 1/16		364N206
J104	Exciter Fil. Vltg. Mtrg. Plug Recept.	4 term. Conn. socket chassis mtg. mtg.			2580	SS-4-AB 1/16		364N204
J105	Automatic Emission Selector Plug Receptacle	15 term. conn. socket chassis mtg.			2580	300		366N215
J106	CFI Output Jack	2 circuit midget phone jack for plugs with ¼″ barrel			3240			358N109
J107	Receptacle for R-F Exc. Conn. Plug P105	Same as J101						
J108	Receptacle for R-F Exc. Conn. Plug P106	Same as J102						
J109	Autotune Motor Conn. Plug Rec.	Same as J103						
J110	P. A. Fil. Vltg. Mtrg. Plug Rec.	2 Term. Female Conn.			3553			368N45
J111	P. A. Fil. Vltg. Mtrg. Plug Rec.	Same as J110						
J112	CFI Unit Input Conn. Plug Recept.	⅜″ dia. 13/16 length for banana-spring type plug			2570	Spec. 74		360N207
J113	Recept., M. O. Heater Fuse	Extractor post type holder for 3AG & 4AG fuses			530	HCM		265N206
J114	Recept. Exc. Fil. Pri. Fuse	Same as J113						
J115	Recept., Int. Amp. Fil. Pri. Fuse	Same as J113						
J116	Recept., Autotune Motor Fuse	Same as J113						
J117	Recept., Autotune Motor Fuse	Same as J113						
J118	Recept., Autotune Motor Fuse	Same as J113						
J119	Recept., P. A. Fil. Pri. Fuse.	Same as J113						
J120	Recept., P. A. Fil. Pri. Fuse	Same as J113						
J121	Recept., V116 Fil. Pri. Fuse	Same as J113						

PARTS LIST BY SYMBOL DESIGNATION

JACKS AND RECEPTACLES (Cont.)

Symbol Desig-nation	Function	Description	Navy Type Desig-nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
J122	Recept., Vltg. Mtrg. Plug	Same as J110						
J201	H. V. Rect. Fil. Vltg. Mtrg. Plug	Same as J110						
J202	H. V. Rect. Fil. Vltg. Mtrg. Plug Receptacle	Same as J110						
J203	L. V. Rect. Fil. Vltg. Mtrg. Plug Receptacle	Same as J110						
J204	Bias Rect. Fil. Vltg. Mtrg. Plug Receptacle	Same as J110						
J205	Receptacle for F201	Same as J113						
J206	Receptacle for F202	Same as J113						
J207	Receptacle for F203	Same as J113						
J208	Receptacle for F204	Same as J113						
J209	Receptacle for F205	Same as J113						
J210	Receptacle for F206	Same as J113						
J211	Receptacle for F207	Same as J113						
J212	Receptacle for F208	Same as J113						
J301	LINE Voltage Metering Cord Plug Receptacle	Same as J113						
J302	FIL. Vltg. Mtrg. Cord Plug Recpt.	Same as J104						
J303	FIL. Vltg. Mtrg. Cord Plug Recpt.	Same as J110						
J304	Mod. Fil. Vltg. Mtrg. Plug Recept.	Same as J110						
J305	Audio Dr. Fil. Vltg. Mtrg. Plug Rec.	Same as J110						
J306	KEY Jack	3 circuit midget phone jack for jacks with 3/16″ d. barrel			4420	TC61		358N102
J307	MICROPHONE Jack	13/16″ Phone Jack			4870	248E		360N116
J308	Receptacle for Speech Amp. Conn. Plug P301	Same as J101						

PARTS LIST BY SYMBOL DESIGNATION

JACKS AND RECEPTACLES (Cont.)

Symbol Desig-nation	Function	Description	Navy Type Desig-nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
J309	Receptacle for Speech Amp. Conn. Plug P302	Same as J102						
J310	Receptacle for Fil. Supply Conn. Plug P303	Same as J101						
J311	Speech Amp. Fil. Vltg. Mtrg. Plug Receptacle	Same as J110						
J312	Handset Conn. Plug Recept.	Same as J104						
J313	Receptacle for F301	Same as J113						
J314	Receptacle for F302	Same as J113						
J315	Receptacle for F303	Same as J113						
J401	KEY Jack	Same as J307						
J402	MICROPHONE Jack	Same as J306						
J403	Receptacle for F401	Extractor type for 1¼ x ¼ cartridge fuse			2920	1075A		265N203

RELAYS

Symbol Desig-nation	Function	Description	Navy Type Desig-nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
K101	Relay, P. A. Overload	Normally open 400 to 800 ma d. c. trip coil and 48 v. d.c. operate coil			4310	CX		405NC4
K102	Relay, PHONE-CW	2 NO 2 NC 48 v d.c. coil cont.			830	GA-514D		514D
K103	Relay, Autotune Motor Reverse	3 PDT 48 v d. c.			2050			405 0007 00
K104	Relay, Autotune Motor Start	3 PDT 48 v d. c.			2050			405NB215
K105	Relay, CW Control	Same as K104						
K106	Relay, Transmitter OFF	DPDT 48 v d. c. Continuous Duty			1820	12665		405NB209
K107	Relay, Slow Release #1	Single wound d. c. nominal rating 75.0 ma at 48 v min. 20 ma at 12.5 v contact rating 110 w 3 amp			140	ASA		972N13
K108	Relay, Slow Release #2	Single wound d. c. nominal 77 ma at 48 v min. 13 ma at 8.0 v contact rating 110 w 3 amp			140	ASA		972N16

PARTS LIST BY SYMBOL DESIGNATION

RELAYS (Cont.)

Symbol Desig-nation	Function	Description	Navy Type Desig-nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
K109	Relay, Homing	Single wound d. c. nominal 38.5 ma at 48.0 v min. 8.5 ma at 12.0 v contact rating 110 w 3 amp.			140	AQA		972N15
K110	Relay, Pulsing	Single wound d. c. nom. 120.0 ma 48 v min. 17.0 ma 6.5 v contact rating 110 w 3 amp			140	AQA		972N1
K111	Relay, V116 Fil. Voltage Control	Same as K106						
K201	Relay, Voltage Control	48 v d.c. coil 2 NO contacts			830	GA-1524B		1524B
K202	Relay, Low Power Plate	Type 50 amp 3 PNO 1 R. Aux. NC 1 L. Aux. NO 220 v 60 cycle			90	Bul.702		405NA4
K203	Relay, High Power Plate	Type 50 amp 3 PNO, 1 Aux. NC 220 v 60 cycle			90	Bul.702		405NA2
K204	Relay, Time Delay	1 PNO Double Break 5 amp 220 v 60 cps contact 230 v 60 cps coil			190	NE-11		402 0001 00
K205	Relay, Filament Power	Type 25 amp 3 PNO 230 v 60 cps coil			90	Bul.702		405NA1
K206	Relay, Plate Power Control	Same as K104						
K207	Relay, Bias Interlock	Double pole NO Coil Operating current 0.5 amp coil resistance approx. 7.5 ohm			1820	27		405NB213
K208	Relay, Bias Holding	Same as K106						
K301	Relay, MCW Oscillator	Single Wound Coil Resistance 1350 ohm Max. current 14 ma 19 v			140	AQA		972N7
K302	Relay, Push-to-Talk	1950 ohms coil Nom. 12 to 24 ma 24 to 48 v Min. 2.5 ma 5.0 v			2740	2C-38-S		408N7
K401	Relay, Receiver Disabling	Same as K302						
K402	Relay, Push-to-Talk	Same as K302						

PARTS LIST BY SYMBOL DESIGNATION

INDUCTORS AND REACTORS

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
L101	Pwr. Amp. Bias Feed Choke	144 turns #24 close wound			830	GA-816D		816D
L102	L102A, L102B	Two Sect. of 81 turns #24 DSC Double Bank Wound			830	GA-815D		815D
L102A	Int. Amp. Output Coupling Choke	Section of L102						
L102B	Int. Amp. Output Coupling Choke	Section of L102						
L103	P. A. Plate Parasitic Suppressor	2-2/3 turns 3/16″ copper tubing			830	GA-1914B		1914B
L104	M. O. Grid Tuning Inductor	18 turns #18 bus close wound			830	GA-2051A		2051A
L105	V101 Cathode Coupling Ch.	2.5 mh 0.125 amp d.c. Resistance 50 ohm Mult. Sect. Duo-lateral wound			3220	R-100U		240N53
L106	V102 Plate Feed Choke	Same as L105						
L107	V103 Grid Choke	1.0 mf 18 ohm dual section			3220			240N23
L108	V101 Grid Choke	Same as L105						
L109	V103 Plate Feed Choke	Same as L105						
L110	V103 Plate Tank Inductor	39 turns #24 DSC Double Bank Wound			830	GA-1435C		1435C
L111	V103 Plate Tank Inductor	21 turns #24 DSC Single Layer Wound			830	GA-1437C		1437C
L112	V104 Grid Choke	Same as L107						
L113	V104 Plate Feed Choke	Same as L105						
L114	V104 Plate Tank Inductor	Same as L110						
L115	V104 Plate Tank Inductor	Same as L111						
L116	V104 Plate Tank Inductor	16 turns #20 single layer wound			830	GA-1438C		1438C
L117	V104 Plate Tank Inductor	6½ turns #18 E.C. space single layer wound			830	GA-1436C		1436C
L118	Int. Amp. Grid Choke	Same as L105						
L119	V109 Grid Choke	Same as L105						
L120	M. O. Plate Feed Choke	Same as L105						
L121	CFI Audio Filter	Single sect. air core 16.0 mh ±10% 110 ohm resistance			3090	19-5590		240N56

PARTS LIST BY SYMBOL DESIGNATION

INDUCTORS AND REACTORS (Cont.)

Symbol Desig- nation	Function	Description	Navy Type Desig- nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig- nation	Spcl. Tol. or Mod.	Contractor's, Drawing or Part Number
L122	P. A. Plate Feed Choke	Same as L101						
L123	L123A, L123B	5½ turns ⅜″ O. D. copper tubing tapped			830			500 2944 00D
L123A	P. A. Plate Tank Inductor	Section of L123						
L123B	P. A. Plate Tank Inductor	Section of L123						
L124	V102 Grid Choke	Same as L107						
L125	P. A. Plate Tank Inductor	31 turns 3/16″ O. D. copper tubing 4-13/16″ I. D. coil			830	GA-701D		701D
L126	Static Drain Choke	Same as L122						
L127	High Frequency Inductor	3 turns 3/16″ O. D. copper tubing			830	GA-1401C		1401C
L128	L128A, L128B	30-1/3 turns .054″ x ¼″ copper strip edge wound			830	GA-1413C		1413C
L128A	P. A. Grid Inductor	Section of L128						
L128B	P. A. Grid Inductor	Section of L128						
L129	P. A. Grid Inductor	3 turns 3/16″ O. D. Copper Tubing			830	GA-1730B		1730B
L130	Relay Supply Filter Reactor	Reactor 2 hy 0.15 amp 50 ohm 120 cps 2500 TV			780	6815		678N159
L131	V101 Plate Choke	Same as L105						
L132	V102 Plate Choke	Same as L105						
L133	V101 Filament Choke	2 pi 0.25 mh/sect 1.0 amp 0.75 ohm			3169			240N52
L134	Int. Amp. Plate Choke	Single Layer-68T-Close wound			830			500 2071 00B
L135	Int. Amp. Grid Choke	Same as L105						
L201	H. V. Filter Reactor	Reactor, 12 hy 0.5 amp inductance measured at 25 v rms 120 cps 12,000 TV			780			678N280
L202	H. V. Filter Reactor	2.0 hy 2.0 amp Nominal 12,500 TV			780	C-8A-70L		678N274
L203	L. V. Filter Reactor	Reactor, 4 hy 0.5 amp 40 ohm 120 cps 2500 TV			780	6315A		678N115A
L204	L. V. Filter Reactor	Same as L203						
L205	Bias Supply Filter Reactor	Same as L203						
L206	Bias Supply Filter Reactor	Same as L203						

PARTS LIST BY SYMBOL DESIGNATION

INDUCTORS AND REACTORS (Cont.)

Symbol Desig-nation	Function	Description	Navy Type Desig-nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
L301	MCW Osc. Tank Reactor	Reactor, 0.0333, 0.0370, 0.0415, 0.0475, 0.0555, 0.0665 hy 0 to 5 v rms, 300 to 1500 cps 1200 TV			780			678N119B
L401	High Voltage Filter Reac.	15 hy 0.02 amp 500 ohm 120 cps 2500 TV			780	6516		678N118A
L402	High Voltage Filter Reac.	Same as L401						

METERS

Symbol Desig-nation	Function	Description	Navy Type Desig-nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
M101	EXCITER GRID CURRENT Meter	D. C. Voltmeter 0-5 v Dual Scale 0-5 ma 0-50 ma			1881 4910	D0-53 301		458N0314CN
M102	INT. AMP. PLATE CURRENT Meter	D. C. Milliammeter 0-500 ma 50 scale divisions appprox. resistance 0.2 ohm			4910	301		450NC500N
M103	PWR. AMP. GRID CURRENT Meter	D. C. Milliammeter 0-300 ma 60 scale divisions approx. resistance 0.33 ohm			4910	301		450NC300N
M104	PWR. AMP. PLATE CURRENT Meter	D. C. Ammeter 0-2.0 amp 40 scale divisions			4910	301 Navy		458N083CN
M105	Antenna Current Meter	A. C. Thermo-ammeter 0-10 amp 50 scale divisions			1881	D0-43		451NS10A
M301	AUDIO LEVEL Meter	Power Level Indicator 16 scale divisions			4910	301		455N2N
M302	PLATE VOLTAGE Meter	D. C. Voltmeter 7.5 kv 75 scale div. 100 v per div.			4910	201		458N023CN
M303	MOD. PLATE CURRENT Meter	Same as M104						
M304	LINE AND FILAMENT VOLTAGE Meter	Spec. Mult. scale a-c voltmeter			4910 1881	476 AC-25		458N061CN
M401	Channel Indicator Meter	D. C. Voltmeter 0-50 v Internal Resistance 100,000 ohms			4910 1881	301		458N035CN
M402	Volume Level Meter	Same as M301						

PARTS LIST BY SYMBOL DESIGNATION

PLUGS

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
P101	Autotune Control Unit Conn. Plug	17 Term. Conn. Plug Assy.			830	AC106B		AC106
P102	Autotune Control Unit Conn. Plug	19 Term. Conn. Plug Assy.			830	AC107A		AC107
P103	CFI Unit Conn. Plug	6 Term. Conn. Plug Chassis Mtg.			2580	P-6-AB1/16		363N206
P104	Automatic Emission Selector Plug	15 Term. Male Conn.			2580	P-315		365N115
P105	R-F Unit Conn. Plug	15 term. conn. plug Assy.			830	AC106C		AC106
P106	R-F Unit Conn. Plug	Same as P102						
P107	Autotune Motor Conn. Plug	6 term. cable conn.			2580	P-406		363N906B
P108	CFI Input Coupling Conn. Plug	Banana-spring plug 6-32 thread			2570			361N206
P301	Speech Amp. Conn. Plug	19 term. conn. plug assy.			830	AC106A		AC106
P302	Speech Amp. Conn. Plug	9 term. conn. plug assy.			830	AC107F		AC107
P303	Fil. Supply Conn. Plug	13 term. cable conn.			830	AC106D		AC106
P304	Voltage Metering Plug	4 term. cable conn.			2580	P-404		363N904
P305	Handset Conn. Plug	4 term. cable conn.			2580	P-4-CCT		363N804B
P401	Power Input Conn. Plug	Two term. male conn. flush mtg. rating 10 amp at 250 v or 15 amp at 125 v.			1881	GE2711		368N37

RESISTORS

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
R101	Resistor Relay Spark Suppressing	510 ohm ±20% 2 w			2360	BT2-Navy		729NH510-M
R102	Res., M. O. Comp. Heater	186 ohm ±20% 18 w Operating Voltage 58 v a. c.			4850	C. No. 1018		711NR2-M
R103	Res., M. O. Comp. Heater	Same as R102						
R104	Res., V101 Cathode	100 ohm ±20% ½ w			2360	BW½		707N100N-M
R105	Res., V102 Cathode	200 ohm ±20% 2 w			2360	133-0200-7		709N200N-M
R106	Res., V102 Screen	30,000 ohm ±20% 2 w			2360	BT2-Navy		729NH30M-M
R107	Res., V103 Grid	51,000 ohm ±20% 2 w			2360	BT2-Navy		729NH51M-M

PARTS LIST BY SYMBOL DESIGNATION

RESISTORS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
R108	Res., V103 Cathode	2400 ohm ±20% 2 w			2360	BT2-Navy		729NH2400-M
R109	Res., V103 Cathode	Same as R108						
R110	Res., V104 Grid	Same as R107						
R111	Res., V104 Cathode	Wire Wound 500 ohm ±20% 15 w			4250			733NXF500-M
R112	Res., V104 Screen	47 ohm ±20% 1 w			4230			729NG47-M
R113	Res., V102 Grid	10,000 ohm ±10% 2 w			2360	BT2-Navy		729NH10M-K
R114	Res., V103 Screen Parasitic Suppressor	Same as R112						
R115	Res., Int. Amp. Grid	2500 ohm ±10% 70 w			4250			733NXC2500-K
R116	Res., Grid Meter Shunting	101 ohm ±1% WW3			2360	WW3		721N101-F
R117	Res., V103 & V104 Screen	22,000 ohm ±20% 2 w			2360	BT2		729NH22M-M
R118	Res., V103 & V104 Screen	Same as R113						
R119	Res., V109 Plate	6800 ohm ±20% 2 w			2360	BT2-Navy		729NH6800-M
R120	Res., V109 Grid	5100 ohm ±20% 2 w			2360	BT2-Navy		729NH5100-M
R121	Res., V101 Plate Voltage Dropping	1500 ohm ±10% 2 w			2360	BT2		729NH1500-K
R122	Res., V101 Plate Voltage Dropping	Same as R121						
R123	Res., V101 Plate Voltage Dropping	Same as R121						
R124	Res., V101 Plate V. Dropping	10,000 ohm ±10% 70 w			4250			733NXC10M-K
R125	Res., Exc. Voltage Div.	16,000 ohm ±10% 2 w			2360	BT2-Navy		729NH16M-K
R126	Res., Exc. Voltage Div.	Same as R125						
R127	Res., Exc. Voltage Div.	5600 ohm ±5% 70 w			4250			733NXC5600-J
R128	Res., Channel Indicator	Same as R125						
R129	Res., Channel Indicator	Same as R125						
R130	Res., Channel Indicator	Same as R125						
R131	Res., Channel Indicator	1000 ohm ±1% WW3			2360	WW3		721N1M-F
R132	Res., Channel Indicator	Same as R131						
R133	Res., Channel Indicator	Same as R131						
R134	Res., Channel Indicator	Same as R131						
R135	Res., Channel Indicator	Same as R131						
R136	Res., Channel Indicator	Same as R131						

PARTS LIST BY SYMBOL DESIGNATION

RESISTORS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
R137	Res., Channel Indicator	Same as R131						
R138	Res., Channel Indicator	Same as R131						
R139	Res., Channel Indicator	Same as R131						
R140	Res., Channel Indicator	Same as R131						
R141	Res., Channel Indicator	Same as R125						
R142	Res., Grid Meter Shunting	1250 ohm ±1% WW3			2360	WW3		721N1250-F
R143	Res., Exc. Voltage Div.	Same as R125						
R144	Res., V111 Anode Grid	24,000 ohm ±10% 2 w			2360	BT2-Navy		729NH24M-K
R145	Res., V113 Grid	100,000 ohm ±20% 2 w			2360	BT2-Navy		729NH100M-M
R146	Res., V110 Plate	510,000 ohm ±20% 2 w			2360	BT2-Navy		729NH510M-M
R147	Res., V110 Grid	1 Megohm ±20% 2 w			2360	BT2-Navy		729NH1Meg-M
R148	Res., V111 Grid	Same as R147						
R149	Res., V110 Grid	20,000 ohm ±20% 2 w			2360	BT2-Navy		729NH20M-M
R150	Res., V111 Grid	36,000 ohm ±10% 2 w			2360	BT2-Navy		729NH36M-K
R151	Res., V113 Cathode	1000 ohm ±20% 2 w			2360	BT2-Navy		729NH1M-M
R152	Res., V113 Cathode	Same as R151						
R153	Res., V110 Plate	Same as R106						
R154	Res., V111 Plate	Same as R125						
R156	Res., V113 Plate	Same as R107						
R157	Res., CFI Voltage Dividing	12,000 ohm ±10% 2 w			2360	BT2-Navy		729NH12M-K
R158	Res., CFI Voltage Dividing	Same as R157						
R159	Res., CFI Voltage Dividing	Same as R150						
R160	Res., V113 Grid	Same as R107						
R161	Res., CFI Voltage Dropping	8000 ohm ±10% 60 w			4250			733NXD8M-K
R162	Res., Int. Amp. Screen	Same as R124						
R163	Res., V101 Screen	Same as R107						
R164	Res., V101 Screen Decoupling	Same as R145						
R165	Res., V103 Grid	Same as R113						
R166	Res., Transient Suppressing	Same as R101						
R167	Res., P. A. Cathode	16 ohm ±20% 25 w			4250			733NXE16-M
R168	Res., MO Output Filter	Same as R120						
R169	Res., C117 Discharging	Same as R147						
R170	Res., Int. Amp. Grid Loading	10,000 ohm ±20% 2 w			2360	BT2-Navy		729NH10M-M

PARTS LIST BY SYMBOL DESIGNATION

RESISTORS (Cont.)

Symbol Desig-nation	Function	Description	Navy Type Desig-nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
R171	Res., Int. Amp. Grid Loading	Same as R170						
R172	Res., Int. Amp. Grid Loading	Same as R170						
R173	Res., Int. Amp. Grid Loading	Same as R170						
R174	Res., Parasite Damping	500 ohm ±20% 15 w			2360			733NXF500-M
R201	Res., Int. Voltage Dropping	2000 ohm ±10% 200 w			3450			733NXA2M-K
R202	Res., Int. Voltage Dropping	Same as R201						
R203	Res., Mod. Bias Control	3 term. rheostat 200 ohm ±5% 100 w			3450	Spec. 0542		738N200A-J
R204	Res. Int. Voltage Bleeder	50,000 ohm ±20% 150 w			4820			733NXB50M-M
R205	Res., Int. Voltage Bleeder	Same as R204						
R206	Res., H. V. Bleeder	31,500 ohm ±20% 200 w			4820			733NXA31500-M
R207	Res., H. V. Bleeder	Same as R206						
R208	Res., H. V. Bleeder	Same as R206						
R209	Res., Plate Voltmeter Multiplier	3 Megohm ±1% 3000v			2360			732NB3.0Meg-F
R210	Res., Plate Voltmeter Mult.	Ferrule 4.5 Megohm ±1% Max. Voltage 4500			2360			732NA4.5Meg-F
R211	Res., I201 Voltage Dropping	2500 ohm ±10% 15 w			2360			733NXF2500-K
R212	Res., I202 Voltage Dropping	Same as R211						
R213	Res., L. V. Supply Bleeder	25,000 ohm ±20% 70 w			2360			733NXC25M-M
R214	Res., P. A. Grid	Same as R201						
R215	Res., P. A. Grid	Same as R201						
R217	Res., Keying Voltage Adjusting	100 ohm ±5% 100 w			3450			738 0001 00
R218	Res., Bias Supply Bleeder	100 ohm ±5% 60 w			2360			733NXD100-J
R219	Res., Bias Supply Bleeder	160 ohm ±5% 150 w			2360			733NXB160-J
R220	Res., Bias Supply Bleeder	Same as R219						
R221	Res., Bias Supply Bleeder	250 ohm ±5% 150 w			2360			733NXB250-J
R222	Res., H. V. Tuning	Strip Heater, Mica Insulation on Term. Rating 1400 w 115 v			4945	SEF-19		711NR1
R223	Res., H. V. Tuning	Same as R222						
R224	Res., H. V. Tuning	Same as R222						
R225	Res., Microphone Voltage Developing	Same as R151						

PARTS LIST BY SYMBOL DESIGNATION

RESISTORS (Cont.)

Symbol Desig- nation	Function	Description	Navy Type Desig- nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig- nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
R301	Res., Audio Input Matching	Same as R119						
R302	Res., Audio Input Matching	Same as R119						
R303	Res., V305 Cathode	2000 ohm ±20% 2 w			2360	BT2-Navy		729NH2M-M
R304	Res., V301 Cathode	Same as R151						
R305	Res., V305 Grid	47,000 ohm ±20% 2 w			2360	BT2		729NH47M-M
R306	Res., V305 Cathode	Same as R151						
R307	Res., V305 Plate	Same as R113						
R308	Res., V305 Plate	Same as R113						
R309	Res., Limiter Bridge	43,000 ohm ±5% 2 w			2360	BT2-Navy		729NH43M-J
R310	Res., Limiter Bridge	30,000 ohm ±5% 2 w			2360	BT2-Navy		729NH30M-J
R311	Res., Limiter Bridge	15,000 ohm ±5% 2 w			2360	BT2		729NH15M-J
R312	Res., V301 Plate	Same as R305						
R313	Res., V301 Plate	Same as R305						
R314	Res., Limiter Bridge	Same as R311						
R315	Res., Limiter Bridge	Same as R310						
R316	Res., Limiter Bridge	Same as R309						
R317	Res., V303 Grid	Same as R145						
R318	Res., V304 Cathode	Same as R151						
R319	Res., V304 Plate Decoupling	Same as R119						
R320	Res., V306 Cathode	5 Megohm ±20% 2 w			2360	BT2-Navy		729NH5Meg-M
R321	Res., V307 Grid	Same as R145						
R322	Res., V308 Grid	Same as R145						
R323	Res., Speech Amp. Voltage Dropping	12,500 ohm ±20% 60 w			2360			733NXD12500-M
R324	R324A, R324B	100,000 ohm Pot. ±20%			2360			380N202
R324A	Res., AUDIO GAIN Control	Section of R324						
R324B	Res., AUDIO GAIN Control	Section of R324						
R325	Res., MCW GAIN Control	100,000 ohm Pot.			2360	9851-9111		380NC100M
R326	R326A, R326B	Same as R324						
R326A	Res., LIMITER GAIN Control	Section of R326						
R326B	Res., LIMITER GAIN Control	Section of R326						

PARTS LIST BY SYMBOL DESIGNATION

RESISTORS (Cont.)

Symbol Desig-nation	Function	Description	Navy Type Desig-nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
R327	Res., Audio Level Metering	510,000 ohm ±10% 2 w			2360	BT2-Navy		729NH510M-K
R328	Res., AUDIO LEVEL Meter Adj.	750,000 ohm Pot.			2360	C. P.		380NA750MA
R329	Res., Audio Level Metering	Same as R327						
R330	Res., Audio Level Metering	Same as R327						
R331	Res., Audio Driver Cathode	2000 ohm ±10% 60 w			2360			733NXD2M-K
R401	Res., Audio GAIN Control	50,000 ohm Pot.			2360	CS		380NC50M
R402	Res., V401 Grid	Same as R145						
R403	Res., V401 Cathode	2700 ohm ±20% 2 w			2360	BT2-Navy		729NH2700-M
R404	Res., V401 Plate Decoupling	Same as R305						
R405	Res., V401 Screen Decoupl.	270,000 ohm ±20% 2 w			2360	BT2-Navy		729NH270M-M
R406	Res., V401 H. V. Dropping	5600 ohm ±20% 2 w			2360	BT2-Navy		729NH5600-M
R407	Res., Feedback Coupling	Same as R147						
R408	Res., V402 Grid	510,000 ohm ±20% 2 w			2360	BT2-Navy		729NH510M-M
R409	Res., V402 Cathode	820 ohm ±20% 2 w			2360	BT2-Navy		729NH820-M
R410	Res., Channel Ind. Adj.	50,000 ohm Pot.			2360	CS		380NA50M
R411	Res., Relay Current Lim.	30,000 ohm ±20% 2 w			2360	BT2-Navy		729NH30M-M
R412	Res., V402 Grid	Same as R407						
R413	Res., H. V. Supply Bleeder	1300 ohm ±20% 2 w			2360	BT2-Navy		729NH1300-M
R414	Res., H. V. Supply Bleeder	Same as R108						
R415	Res., H. V. Supply Bleeder	Same as R108						
R416	Res., H. V. Supply Bleeder	Same as R108						
R417	Res., Control Voltage Dev.	1100 ohm ±20% 2 w			2360	BT2-Navy		729NH1100-M
R418	Res., Control Voltage Dev.	Same as R417						
R419	Res., Control Voltage Dev.	Same as R417						
R420	Res., V402 Cathode	Same as R147						
R421	Res., Disabling Circuit Adjusting	10,000 ohm wire wound Potentiometer			2360	W-10000		381NA10M
R422	Res., V402 Plate	10,000 ohm ±20% 2 w			2360	BT2-Navy		729NH10M-M

PARTS LIST BY SYMBOL DESIGNATION

SWITCHES

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
S101	Switch, CFI Power	2 Pole, 2 Pos. 1 sect. non-shorting with 60 degree detent			700			259N103A
S102	Switch, V103 Plate Tank	Rotor—3 contact, Stator—18 contact			830			186M-8
S103	Switch, V104 Plate Tank	Same as S102						
S104	Switch, V104 Plate Tank	Same as S102						
S105	Switch, Grid Meter Switch	DPDT Lever Current Ratings 1 amp at 250 v 3 amp at 125 v a. c. or d. c. toggle			2160	20905-GH		266N103
S106	Switch, Automatic Emission	1 circuit shorting 12 pos. contact spacings 30 degrees			3410	DH		269N36
S107	Switch, Channel Indicator	Same as S106						
S108	Switch, Circuit Seeking	1 circuit non-shorting 12 pos.			3410	DH		269N37
S109	Switch, Autotune Limit	DP 1NC 1 NO contact leaf			830	GA-1557B		GA-1557B
S110	Switch, M. O. Comp. Thermostat	Thermoswitch 10 amp 115 v or 5 amp 230 v range 0-400 degrees F.			1653	731RC		292N24
S111	Switch, P. A. Plate Tank	9 contact shorting switch 4 rotor arms			830	GA-1473C		GA-1473C
S112	Switch, P. A. Grid Tank	Stator—18 Contact			830	GA-1732B		1732B
		Rotor—4 Arm			830	GA-1882B		1882B
S113	Switch, Autotune Rotary Stepping	25 pt. 4 levels 1 bridging 3 non-bridging interrupter springs 447 ma 48.0 v operating			288	H-70228		978N2
S114	Switch, Front Door Interlock	Male Section			1881			260N404
		Female Section			1881			260N405
S115	Switch, Rear Panel Interlock	Same as S114						
S116	Switch, P. A. Grid Tank	Same as S112						
S201	Switch, FILAMENT START	Normally open, Black Button			2160	27900		260N202
S202	Switch, FILAMENT STOP	Normally closed, Red Button			2160	27900		260N203
S203	Switch, PLATE START	Same as S201						
S204	Switch, PLATE STOP	Same as S202						
S205	Switch, Power Level	Same as S105						

PARTS LIST BY SYMBOL DESIGNATION

SWITCHES (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
S206	Switch, TUNE-OP.	3 Pole non-shorting 3 pos. 3 gang heavy duty top sw. 50 amp at 300 v 25 amp at 600 v			3450	412-3-T3		259N147
S207	Switch, Voltage Control	1 NC Contact leaf Spring Sw. Assembly Contacts ⅛'' Diameter Silver			2050			269N40
S208	Switch, Front Door Interlock	Same as S114						
S209	Switch, Rear Panel Interlock	Same as S114						
S210	Switch, ADJUST-OPERATE	Same as S105						
S211	Switch, Transmitter Power	Magnetic-Time Delay Triple Pole Three Overload Coils Rating 50 amps 230 v a. c.			2210	0342		260N452TC
S301	TEST Switch	Pos. 1: 2c, Pos. 2: 2c Palladium Contact Points Max. Rating 110 w 3 amp.			140	H-70224-1		374N1
S302	Telephone Dial	Splash Proof Delayed Impulse 11 Pts Interrupter Spring NC			140	H-70227		978N1
S303	LOCAL-REMOTE Switch	Locking in Pos 1, Non-locking in Pos 2. Contact arrangement Pos 1: 6c, 1B Pos 2: None, Max. Rating: 110 w 3 amp			140	H77041-3		374N5
S304	MCW FREQUENCY Control Switch	Open Tap Sw. 1 Pole 7 Pos. 1 Sec. shorting			700			259N106
S305	Front Door Interlock Switch	Same as S114						
S306	Rear Panel Interlock Sw.	Same as S114						
S307	Handset Mounting Hook Sw.	Handset Mounting without Brkt. 2 NC Contact Leaf Sw.			4870	G1 Type		977N35
S308	Switch, Air Interlock	(Micro) Snap SPST No Rating: 1000 w 3 amp ac at 450 v 5 amp ac at 250 v 10 amp ac at 115 v			18			260 0002 00
S401	Telephone Dial	Same as S302						
S402	Power Input Switch	Same as S105						
S403	Input Circuit Selector Sw.	Same as S105						

PARTS LIST BY SYMBOL DESIGNATION

TRANSFORMERS

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
T102	Transformer, Int. Amp. Filament	Pri: 210, 220, 230, 240, 250 v 50/60 cps 100 VA Sec: 10 v 10.0 amp 2500 TV			780			672N109C
T103	Transformer, Exciter Filament	Pri: 210, 220, 230, 240, 250, v 31.5 VA Sec: 6.3 v 5.0 amp 2500 TV			780			672N112A
T104	Transformer, P. A. Filament	Pri: 210, 220, 230, 240, 250 v 180 VA Sec: 7.5 v 24.0 amp 2500 TV			780			672N211
T105	Transformer, P. A. Fil.	Same as T104						
T106	Transformer, CFI Output Coupling	Pri: 10,000 ohm Sec: 500 ohm 100-4000 cps 0.25 w			780			677 0001 00
T107	Transformer, V116 Filament	Pri: 210, 220, 230, 240, 250 v Sec: 6.3 v 5.0 amp CT 2500 TV			780			672N112A
T201	Transformer, H. V. Rect. Filament	Pri: 220, 230, 240 v 50/60 cps 150 VA Sec #1: 5 v 10 amp rms Sec #2: 5 v 10 amp rms Sec #3: 5 v 10 amp rms			780			672N210A
T202	Transformer, H. V. Rect. Fil.	Same as T201						
T203	Transformer, H. V. Power	3 Phase 4000 v & 2000 v Low Voltage Combination 5250 v & 2685 H. V. Combination			780 2900			672N275
T204	Transformer, Relay Rect. Supply	Pri: 210, 220, 230, 240, 250 v 50/60 cps Sec #1: 150 v 0.75 amp 2500 TV Sec #2: 110 v 0.5 amp 2500 TV			780	C-4B-40		674N269
T205	Transformer, L. V. Rect. Plate	Pri: 210, 220, 230, 240, 250 v 50/60 cps 300 VA Sec: 1200 v 0.353 amp 2500 TV			780			672N209
T206	Transformer, Bias Rect. Pl.	Same as T205						
T207	Transformer, L. V. Rect. Filament	Pri: 210, 220, 230, 240, 250 v 50/60 cps 37.5 VA Sec: 2.5 v 15.0 amp 2500 TV			780	6510		672N148

PARTS LIST BY SYMBOL DESIGNATION

TRANSFORMERS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
T208	Transformer, Bias Rect. Filament	Same as T207						
T209	Transformer, Input Voltage Adj.	Pri: 220, 230, 240, v 50/60 cps 300 VA 2500 TV			780	6809		674N167
T210	Transformer, Input Voltage Adj.	Same as T209						
T301	Transformer, Audio Input	Pri #1: 500 ohm 100/5000 cps 50 mw Max. Pri #2: 75 ohm 1000 TV Sec #1: 40,000 ohm 1000 TV			780			677N270
T302	Transformer, Audio Coupl.	Pri: 20,000 ohm 30/10,000 cps Sec #1: 20,000 ohm 1500 TV Sec #2: 20,000 ohm 1500 TV			4450 780	T44542 CD141		677N141
T303	Transformer, Audio Coupl.	Pri: 10,000 ohm 100/5000 cps 0.2 w max. Sec: 40,000 ohm 1000 TV			4450			677N102A
T304	Transformer, Audio Amp. Output Coupling	Pri: 16,000 CT 100 to 5000 cps Sec: 64,000 CT 3000 TV			780			677N278
T305	Transformer, Audio Driver Filament	Pri: 210, 220, 230, 240, 250 v 50/60 cps 65 VA Sec #1: 10 Volts 3.25 amp rms 4000 TV CT Sec #2: 10 Volts 3.25 amp 4000 TV CT			780	C-2B3-40		672N279
T306	Transformer, Audio Driver Output Coupling	Pri: 15,000 ohm CT 100/5000 cps Sec: 15,000 ohm CT 2500 TV			780	8069		677N277
T307	Transformer, Mod. Filament	Same as T104						
T308	Transformer, Speech Amp. Filament	Pri: 210, 220, 230, 240, 250 v 50/60 cps Sec #1: 6.3 v CT 3.0 amp Sec #2: 7.5 v CT 3.0 amp 2500 TV			780			672N276

PARTS LIST BY SYMBOL DESIGNATION

TRANSFORMERS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
T309	Transformer, Modulation	Pri: 12,000 ohm CT 100-5000 cps 15,000 TV Sec: 4000 ohm			780			667S712
T310	Transformer, Handset Coupling	Pri: 500 ohm CT 100-5000 cps Sec: 500 ohm CT 1500 TV			4450			677N144
T401	Transformer, Audio Input	Same as T301						
T402	Transformer, Audio Output	Pri: 15000 ohm CT 100-5000 cps Sec: 500 ohm 2000 TV			4450			677N143
T403	Transformer, Power	Pri: 105, 110, 115, 120, 125 v 50/60 cps Sec #1: 400 v 0.025 amp Sec #2: 6.3 v 2.0 amp 2500 TV			780			672N255

VACUUM TUBES

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
V101	Tube, Master Oscillator	Pentagrid Converter	6A8		* *	6A8		
V102	Tube, R-F Amplifier	Video Power Amp. Pentode	6AG7		* *	6AG7		
V103	Tube, Frequency Mult.	Beam Power Amplifier	807		* *	807		
V104	Tube, Frequency Mult.	Same as V103						
V105	Tube, Int. Amplifier	Beam Pentode Power	813		* *	813		
V106	Tube, Intermediate Amp.	Same as V105						
V107	Tube, Voltage Regulator	Voltage Regulator	VR150-30		* *	VR150-30		
V109	Tube, Keyer	Triple Grid Detector Amp.	6SJ7		* *	6SJ7		
V110	Tube, CFI Converter	Twin Triode Amplifier	6SL7GT		* *	6SL7GT		
V111	Tube, CFI Oscillator	Same as V101						
V113	Tube, CFI Audio Amp.	Twin Triode Amplifier	6SN7GT		* *	6SN7GT		
V114	Tube, Power Amplifier	Transmitting Triode			3260	750TL		
V115	Tube, Power Amplifier	Same as V114						
V116	Tube, Parasitic Suppressor	Transmitting Triode	811		* *	811		
V201	Tube, High Voltage Rect.	Half-wave Rectifier			* *	872A		
V202	Tube, High Voltage Rect.	Same as V201						
V203	Tube, High Voltage Rect.	Same as V201						

PARTS LIST BY SYMBOL DESIGNATION

VACUUM TUBES (Cont.)

Symbol Desig- nation	Function	Description	Navy Type Desig- nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig- nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
V204	Tube, High Voltage Rect.	Same as V201						
V205	Tube, High Voltage Rect.	Same as V201						
V206	Tube, High Voltage Rect.	Same as V201						
V207	Tube, Low Voltage Rect.	Half-wave Rectifier			* *	866/866A		
V208	Tube, Low Voltage Rect.	Same as V207						
V209	Tube, Bias Rectifier	Same as V207						
V210	Tube, Bias Rectifier	Same as V207						
V301	Tube, Audio Amplifier	Same as V110						
V302	Tube, Audio Limiter	Twin-Triode	6C8G		* *	6C8G		
V303	Tube, Audio Squelch	Same as V302						
V304	Tube, Audio Amplifier	Same as V109						
V305	Tube, MCW Oscillator	Same as V113						
V306	Tube, Limiter Rectifier	Full Wave High Vacuum Rect.	6X5GT		* *	6X5GT		
V307	Tube, Audio Amplifier	A. F. Power Amplifier	801			801		
V308	Tube, Audio Amplifier	Same as V307						
V309	Tube, Audio Driver	A-F Power Amplifier	845			845		
V310	Tube, Audio Driver	Same as V309						
V311	Tube, Modulator	Transmitting Triode			3260	450TL		
V312	Tube, Modulator	Same as V311						
V401	Tube, Audio Amplifier	Same as V109						
V402	Tube, Audio Amp.-Disabling Amp.	Same as V113						
V403	Tube, Power Rectifier	Same as V306						

SOCKETS

Symbol Desig- nation	Function	Description	Navy Type Desig- nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig- nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
X101	Socket for V101	8 term. Iso Tube Socket			2570			220N581
X102	Socket for V102	Same as X101						
X103	Socket for V103	5 Term. Iso Tube Socket			2570	225		220N552
X104	Socket for V104	Same as X103						

** Produced by numerous will known manufacturers

PARTS LIST BY SYMBOL DESIGNATION

SOCKETS (Cont.)

Symbol Desig-nation	Function	Description	Navy Type Desig-nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
X105	Socket for V105	7 Term. "Jumbo" Wafer Type Socket			2570	237		220N571
X106	Socket for V106	Same as X105						
X107	Socket for V107	Same as X101						
X109	Socket for V109	Same as X101						
X110	Socket for V110	Same as X101						
X111	Socket for V111	Same as X101						
X112	Socket for V112	Same as X101						
X113	Socket for V113	Same as X101						
X114	Socket for V114	4 prong porcelain base			2570	214		220N544
X115	Socket for V114	Same as X114						
X116	Socket for V116	4 term. low loss ceramic			2570	224		220N545
X201	Socket for V201	Four term. tube socket bayonet lock 50 w base			2570	211		220N542
X202	Socket for V202	Same as X201						
X203	Socket for V203	Same as X201						
X204	Socket for V204	Same as X201						
X205	Socket for V205	Same as X201						
X206	Socket for V206	Same as X201						
X207	Socket for V207	Four prong socket bayonet lock UX Base			3230	XM-10		220N641
X208	Socket for V208	Same as X207						
X209	Socket for V209	Same as X207						
X210	Socket for V210	Same as X207						
X211	Socket for I201	Pilot Light Mtg. for Candelabra base bulbs			1200	75		262N136
X212	Socket for I202	Same as X211						
X301	Socket for V301	Same as X101						
X302	Socket for V302	Same as X101						
X303	Socket for V303	Same as X101						
X304	Socket for V304	Same as X101						

PARTS LIST BY SYMBOL DESIGNATION

SOCKETS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
X305	Socket for V305	Same as X101						
X306	Socket for V306	Same as X101						
X307	Socket for V307	Same as X116						
X308	Socket for V308	Same as X116						
X309	Socket for V309	Same as X201						
X310	Socket for V310	Same as X201						
X311	Socket for V311	Same as X201						
X312	Socket for V312	Same as X201						
X401	Socket for V401	Same as X101						
X402	Socket for V402	Same as X101						
X403	Socket for V403	Same as X101						

I-F TRANSFORMERS, ETC.

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
Z101	CFI Osc. Tank Circuit	200 kc Oscillator Coil Assy. Min. Tuning Range: 185 to 215 kc.			4170			278N39
Z102	V111 Plate Tank Circuit	50 kc Tank Coil Assy. Min. Tuning Range: 45 to 55 kc.			4170 4860 70			278N41
Z103	V110 Plate Tank Circuit	150 kc Tank Coil Assy. Min. Tuning Range: 135 to 165 kc.			4170 4860 70			278N42
Z104	CFI Unit Filter Circuit	Same as Z102						

SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY MODEL TDH RADIO TRANSMITTING EQUIPMENT

Quan.	Navy Type Number	All Symbol Designations Involved	Description	Navy Spec. or Dwg. No.	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
1		B301	Motor Starting, Replacement capacitor		2266			234 0001 00
2		C101	Mica, 6000 mmf ±20% 1000 TV		911 4030 4210	9L A2-10 XMB		910N260A-M
2		C107	Mica, 0.002 mf ±20% 6000 TV (9, 6, 4, 2) Low Loss Case		911	Type 6		906N220H-M
1		C111	Ceramic .0023 mf ±5% Coeff. Neg. 40 ppm/°C. ±5 ppm/°C		700			913 0006 00
1		C112	Ceramic, 0.0003 mf ±2½% 500 TV DC		700	814		913 0004 00
1		C113	.001 mf ±5% Coeff. Neg. 750 ppm/°C. ±15%/°C.		700			913 0007 00
2		C114, C115, C146	0.1/0.1/0.1 mf Foil Paper ±20% 600 WV DC		911 4210 4250	 2527-8		956NT01W-M
1		C118, C120	Foil Paper, 0.1/0.1 mf ±20% 600 WV		911 4250 2330			956ND01W-M
6		C119, C125, C130, C168 C142, C143, C145, C170, C171, C172	Mica, 0.006 mf ±20% 1500 TV Low Loss		4030	Type BE-15		915N260E-M
2		C121, C122, C404	Foil paper, 0.1 mf ±20% 600 WV		911			956NS01W-M
6		C123, C126, C128, C131, C133, C137, C139, C141, C175, C176, C178	Mica, 0.001 mf ±20% 1500 TV Low Loss		4030	Type BE-15		915N210E-M
1		C124, C129	Single Sect. Foil Paper, 0.1 mf ±20% 600 WV		4250 911 4210			956NS01Y-M
2		C134, C135, C136	Mica, 0.01 mf ±20% 1000 TV Low Loss Case		911 4030 4210	9L		910N110A-M
1		C140	Silvered Mica, 0.001 mf ±20% 500 TV DC		4170			912N210H-M
1		C144	Silvered Mica 0.00025 mf ±20% 1500 TV Low Loss Case		4030	BE-15		915N325E-M

SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY MODEL TDH RADIO TRANSMITTING EQUIPMENT

Quan.	Navy Type Number	All Symbol Designations Involved	Description	Navy Spec. or Dwg. No.	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
1		C147, C149	Single Sect. Foil paper .02 mf ±20% 600 WV d. c.		911 4210 4250			956NS14W-M
1		C148	Paper 0.5 mf ±20% 600 WV d.c.		911	DYRT		956NS08W-M
3		C401	Paper 0.25 mf ±20% 600 WV d. c.		911 4210 4250			956NS05W-M
4		C150	Mica, 0.001 mf ±20% 1000 TV d.c.		911			910N210D-M
1		C154	Mica, 2000 mmf ±20% 10,000 TV 60 cycles rms max. current 16.0 amp at 3000 kc, 14.0 amp at 1000 kc, 8.0 amp at 300 kc, 4.0 amp at 100 kc.		911	50		900N220-M
7		C203, C205, C301, C309, C403, C405	Paper 4/4/4 mf ±20% 600 WV		911	KC-6		956NT7J-M
1		C165	Paper, 0.25 mf ±20% 600 WV		911 4210	DYR XDMR		956NS05Y-M
1		C166	Paper, 4.0 mf ±20% 7500 WV		911	TK-70040		930N91-M
1		C167	Paper, 4.0 mf ±20% 4000 WV		911	TJ-40040A		930N45A-M
2		C302, C306, C307, C308	Paper, 0.25 mf ±20% 600 WV		911 4210	DYR XDMR		956NS05V-M
2		C303, C304, C402	Paper, 0.1 mf ±20% 600 WV		4210 911 3125			956NS01V-M
1		C305	Paper, 0.5 mf ±20% 600 WV		911 4210	DYRB XDMB		956NS08V-M
1		C310	Paper, 0.22 mf 0.3 mf 0.4 mf 0.55 mf 0.82 mf 1.4 mf 2.8 mf ±10% 600 WV		911			956NM1-K
1		C177	.0001 mf ±20% 1500 TV		4030	BE-15		915N310E-M
1		C311, C312	Paper, 4 mf ±20% 600 WV		911	TJ-6040		930N30A-M
1		E101, E102	Special h-f parasitic suppr.		830	GA-1064A		GA-1064A
30		F101, F302, F303	⅜ amp 250 v 4 ohm average resistance 1¼ x ¼ cart. slo-blo		2920	3AG		264N425
40		F102, F109, F401	¼ amp 250 v average resis. 8 ohm 1¼ x ¼ cart. slo-blo		2920	3AG		264N424

SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY MODEL TDH RADIO TRANSMITTING EQUIPMENT

Quan.	Navy Type Number	All Symbol Designations Involved	Description	Navy Spec. or Dwg. No.	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
10		F103	¾ amp 250 v aver. resis. 1 ohm 1¼ x ¼ cart. slo-blo		2920	3AG		264N427
30		F104, F105, F106	8 amp 250 v 1¼ x ¼ cartridge		2920	3AG		264N411
30		F107, F108, F203, F204	2 amp 250 v 1¼ x ¼ cartridge		2920	3AG		264N407
					530	3AG		
50		F201, F202, F204, F205, F208	3 amp 250 v 1¼ x ¼ cartridge		2920	3AG		264N408
					530	3AG		
20		F206, F207	1 amp 250 v 1¼ x ¼ cartridge		2920	3AG		264N405
50		F301	1 amp 250 v 1¼ x ¼ cartridge		2920	3AG		264N428
10		F304	2 amp 5000 v 5″ x 13/16″ cartridge		2920	3026		264N819
6		I201, I202	110 v 55 ma 6 w Candelabra Base		1881	T-4-½		262N333
6		I401	6.3 v 0.15 amp Miniature Bayonet Base		1881	47		262N324
					3846	R40A		
1		K101	Current Type Res. 20 ohm 400 to 800 ma d. c.		4310	PB		406NC5
1		K101	Voltage Type Res. 48 v d. c.		4310	M		406NC6
4		K101	15/16″ Replacement Fixed Contact & Bakelite Block		4310			406NC7
2		K101	2⅞″ Contact assembly movable		4310			406NC8
8		K102, K201	⅜″ Silver Contact 1 15/16″ x ⅜″		4840			404N17
12		K102, K201	⅜″ Silver Contact ⅞″ x ⅜″		4820			404N18
4		K102	⅜″ Movable Silver Contact		4820			404N38
2		K102, K201	48 v d. c. 680 ohm d. c. resist.		4840	13L21		406NP1
2		K103	3PDT 48 v d. c.		4820			405 0007 00
6		K104, K105, K206	3 PDT 48 v d. c. nom. 3 phase 60 cy.		2050			405NB215
6		K106, K208, K111	DPDT 48 v d. c. continuous duty		1820	12665		405NB209
2		K107	1 set of cont. springs for 48 v double arm relay		140	H-73507-5		973N5
2		K107, K108	Tele. Type 48 v dc Nom. 600 ohm Res.		140	66645-172		973N26
2		K108	1 set r. mtg. contact springs for 48 v d. c. relay		140	H-77029-5		973N28
2		K109	1 set of r. mtg. contact springs for 48 v d.c. relay		140	H-77029-3		973N27

SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY MODEL TDH RADIO TRANSMITTING EQUIPMENT

Quan.	Navy Type Number	All Symbol Designations Involved	Description	Navy Spec. or Dwg. No.	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
2		K109, K301	Telephone type coil assy. for 48 v relays		140	H-70226-14		973N18
2		K110	1 set of right mtg. contact springs for 48 v single arm relay		140	H-70357-1		973N1
1		K110	Telephone Type Coil Assy for 972N1 relay		140	H-70226-12		973N16
2		K202, K203	Replacement Coil for 50 amp Contactor 230 v 50-60 cps 3 PNO d. c. Res: 30 ohm		90	RC		406NA6
24		K202, K203	Stationary Type, Rating 50 amp		90			406NA12
6		K202, K203	Aux. Contact for R. Mtg. NC or L. Mtg. NO Contact		90			406NA13
12		K203	Replacement Contact rating 50 amp		90			406NA11
1		K204	220 v 60 cycle a. c. relay coil		190			404N68
2		K204	Relpacement relay contact assy.		190			404N69
1		K205	Relpacement coil 230 v 60 cps 3 PNO		90	RC-3406		406NA1
2		K205	Aux. NO Contact Switch 3 amp 110 v rating		90	L-90		406NA4
2		K205	Aux. NO Contact Switch		90	L-92		406NA5
6		K205	Replacement Contact. Rating: 25 amp		90			406NA9
12		K205	Stationary Type Cont. Rating: 25 amp		90	X-33519		406NA10
2		K207	Double Pole NO Coil. Operating current 0.5 amp coil resistance approx. 7.5 ohm		1820	27		405NB213
2		K301	Set of contact springs for 48 v double arm relay		140	H-70357		973N13
5		K302, K401, K402	1950 ohm specially impregnated coil		2740	#38		409N10
10		K302, K401, K402	1⅝″ Mica Insulated Armature and Contact		2740	205A		409N12
20		K302, K401, K402	Stationary Thumb Screw Cont. 11/32″ D		2740			409N13
1		M101	D. C. Voltmeter 0-5 v dual scale 0-5 ma 0-50 ma		1881	DO-53		458N0314CN

SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY MODEL TDH RADIO TRANSMITTING EQUIPMENT

Quan.	Navy Type Number	All Symbol Designations Involved	Description	Navy Spec. or Dwg. No.	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
1		M102	D. C. Milliammeter 0-500 ma 50 scale divisions approx. res. 0.2 ohm		4910	301		450NC500N
1		M103	D. C. Milliammeter 0-300 ma 60 scale div. approx. res. 0.33 ohm		4910	301		450NC300N
1		M104, M303	D. C. Ammeter 0-2 amp 40 scale div.		4910	301 Navy		458N083CN
1		M105	A. C. Thermo-ammeter 0-10 amp 50 scale div.		1881	D0-43		451NS10A
1		M301, M402	Power Level Indicator 16 scale div.		4910	301		455N2N
1		M302	D. C. Voltmeter 7.5 kv 75 scale div. 100 v per div.		4910	301		458N023CN
1		M304	Spec. Mult. Scale A. C. Voltmeter		4910 1881	476 A0-25		458N061CN
1		M401	D. C. Voltmeter 0-50 v. Internal Res. 100,000 ohm		4910 1881	301		458N035CN
1		R102, R103	186 ohm ±20% 18 w		2360	BT2-Navy		711NR2-M
1		R104	100 ohm ±20% ½ w		2360	BW½		707N100N-M
1		R105	200 ohm ±20% 2 w		2360	133-0200-7		709N200N-M
3		R106, R153, R411	30,000 ohm ±20% 2 w		2360	BT2-Navy		729NH30M-M
3		R107, R110, R156, R160, R163	51,000 ohm ±20% 2 w		2360	BT2-Navy		729NH51M-M
4		R108, R109, R414, R415, R416	2400 ohm ±20% 2 w		2360	BT2-Navy		729NH2400-M
1		R111, R174	Wire Wound 500 ohm ±20% 15 w		4250			733NXF500-M
1		R112, R114	47 ohm ±20% 1 w		4230			729NG47-M
4		R113, R118, R165, R170, R171, R172, R173	10,000 ohm ±10% 2 w		2360	BT2-Navy		729NH10M-K
1		R115	2500 ohm ±10% 70 w		4250			733NXC2500-K
1		R116	101 ohm ±1% WW3		2360	WW3		721N101-F
1		R117	22,000 ohm ±20% 2 w		2360	BT2		729NH22M-M
1		R119, R301, R302, R319	6800 ohm ±20% 2 w		2360	BT2-Navy		729NH6800-M
3		R120, R168	5100 ohm ±20% 2 w		2360	BT2-Navy		729NH5100-M
2		R121, R122, R123	1500 ohm ±10% 2 w		2360	BT2		729NH1500-K
1		R124, R162	10,000 ohm ±10% 70 w		4250			733NXC10M-K
4		R125, R126, R128, R129, R130, R143, R154	16,000 ohm ±10% 2 w		2360	BT2-Navy		729NH16M-K
1		R127	5600 ohm ±5% 70 w		4250			733NXC5600-J

SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY MODEL TDH RADIO TRANSMITTING EQUIPMENT

Quan.	Navy Type Number	All Symbol Designations Involved	Description	Navy Spec. or Dwg. No.	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
5		R131, R132, R133, R134, R135, R136, R137, R138, R139, R140, R141	1000 ohm ±1% 1 w		2360	WW3		721N1M-F
1		R142	1250 ohm ±1% 1 w		2360	WW3		721N1250-F
1		R144	24,000 ohm ±10% 2 w		2360	BT2-Navy		729NH24M-K
4		R145, R164, R317, R321, R322, R402	100,000 ohm ±20% 2 w		2360	BT2-Navy		729NH100M-M
1		R101, R166	510 ohm ±20% 2 w		2360	BT2-Navy		729NH510-M
3		R151, R152, R225, R304, R306, R318	1000 ohm ±20% 2 w		2360	BT2-Navy		729NH1M-M
1		R150, R159	36,000 ohm ±10% 2 w		2360	BT2-Navy		729NH36M-K
1		R157, R158	12,000 ohm ±10% 2 w		2360	BT2-Navy		729NH12M-K
5		R147, R148, R407, R412, R420, R169	1 Megohm ±20% 2 w		2360	BT2-Navy		729NH1Meg-M
1		R161	8000 ohm ±10% 60 w		4250			733NXD8M-K
1		R167	16 ohm ±20% 25 w		4250			733NXE16-M
2		R201, R202, R214, R215	2000 ohm ±10% 200 w		3450 4820			733NXA2M-K
1		R204, R205	50,000 ohm ±20% 150 w		4820			733NXB50M-M
2		R206, R207, R208	31,500 ohm ±20% 200 w		4820			733NXA31500-M
1		R209	3 Megohm ±1% 3000 v		2360			732NB3.0Meg-F
1		R210	Ferrule 4.5 Meg. ±1% Max. Voltage 4500		2360			732NA4.5Meg-F
1		R211, R212	2500 ohm ±10% 15 w		2360			733NXF2500-K
1		R213	25,000 ohm ±20% 70 w		2360			733NXC25M-M
1		R217	100 ohm ±5% 100 w		3450			738 0001 00
1		R218	100 ohm ±5% 60 w		2360			733NXD100-J
1		R149	20,000 ohm ±20% 2 w		2360	BT2-Navy		729NH20M-M
1		R219, R220	160 ohm ±5% 150 w		2360			733NXB160-J
1		R221	250 ohm ±5% 150 w		2360			733NXB250-J
1		R303	2000 ohm ±20% 2 w		2360	BT2-Navy		729NH2M-M
3		R305, R312, R313, R404	47,000 ohm ±20% 2 w		2360	BT2		729NH47M-M
2		R307, R308, R414	10,000 ohm ±10% 2 w		2360	BT2-Navy		729NH10M-M
1		R309, R316	43,000 ohm ±5% 2 w		2360	BT2-Navy		729NH43M-J

SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY MODEL TDH RADIO TRANSMITTING EQUIPMENT

Quan.	Navy Type Number	All Symbol Designations Involved	Description	Navy Spec. or Dwg. No.	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
1		R310, R315	30,000 ohm ±5% 2 w		2360	BT2-Navy		729NH30M-J
1		R311, R314	15,000 ohm ±5% 2 w		2360	BT2		729NH15M-J
1		R320	5 Megohm ±20% 2 w		2360	BT2-Navy		729NH5Meg-M
1		R323	12,500 ohm ±20% 60 w		2360			733NXD12500-M
2		R327	510,000 ohm ±10% 2 w		2360	BT2-Navy		729NH510M-K
1		R331	2000 ohm ±10% 60 w		2360			733NXD2M-K
1		R403	2700 ohm ±20% 2 w		2360	BT2-Navy		729NH2700-M
1		R405	270,000 ohm ±20% 2 w		2360	BT2-Navy		729NH270M-M
1		R406	5600 ohm ±20% 2 w		2360	BT2-Navy		729NH5600-M
2		R408, R146	510,000 ohm ±20% 2 w		2360	BT2-Navy		729NH510M-M
1		R409	820 ohm ±20% 2 w		2360	BT2-Navy		729NH820-M
1		R413	1300 ohm ±20% 2 w		2360	BT2-Navy		729NH1300-M
5		R417, R418, R419	1100 ohm ±20% 2 w		2360	BT2-Navy		729NH1100-M
4		V101, V111	Pentagrid Converter	6A8	* *	6A8		
2		V102	Power Amp. Pentode	6AG7	* *	6AG7		
4		V103, V104	Beam Power Amplifier	807	* *	807		
4		V105, V106	Beam Power Amplifier	813	* *	813		
2		V107	Voltage Regulator	VR150-30	* *	VR150-30		
8		V109, V304, V401	Triple Grid Amp.	6SJ7	* *	6SJ7		
4		V110, V301	Twin Triode Amp.	6SL7GT	* *	6SL7GT		
8		V113, V305, V402	Twin Triode Amp.	6SN7GT	* *	6SN7GT		
4		V114, V115	Transmitting Triode	750TL	3260	750TL		
2		V116	Transmitting Triode	811	* *	811		
12		V201, V202, V203, V204, V205, V206	Half-Wave Rectifier	872A	* *	872A		
8		V207, V208, V209, V210	Half-Wave Rectifier	866/866A	* *	866/866A		
4		V302, V303	Twin Triode	6C8G	* *	6C8G		
6		V306, V403	Full-Wave Rectifier	6X5GT	* *	6X5GT		
4		V307, V308	A-F Power Amp.	801	* *	801		
4		V309, V310	A-F Power Amp.	845	* *	845		
4		V311, V312	Transmitting Triode	450TL	3260	450TL		

* These tubes produced by numerous well known manufacturers.

APPENDIX

LIST OF MANUFACTURERS

Code No.	Mfr.'s Prefix	Name	Address
18		Arco Electric Co.	3167 Fulton Road Cleveland, Ohio
60	COA	The Akron Porcelain Company	Kenmore Station Akron, Ohio
90	CBZ	Allen Bradley Company	136 West Greenfield Avenue Milwaukee 4, Wisconsin
140	CAU	Automatic Electric Sales Corp.	1033 West Van Buren Street Chicago, Illinois
190		American Gas Accumulator Co.	1003 Newark Avenue Elizabeth, New Jersey
288		Auto Electric Shop	209 Seventh Street S.E. Cedar Rapids, Iowa
380		The Benwood Linze Company	1811-19 Locust Street St. Louis, Missouri
530	CFA	Bussman Mfg. Company Div. of the McGraw Elec. Co.	University of Jefferson St. Louis, Missouri
700	CBN	Centralab	900 E. Keefe Ave. Wilwaukee 1, Wisconsin
780	CTR	Chicago Transformer Corp.	3501 Addison Street Chicago 18, Illinois
830	COL	Collins Radio Company	855 35th Street N.E. Cedar Rapids, Iowa
911	CD	Cornell Dubilier Corporation	333 Hamilton Blvd. South Plainfield, New Jersey
920	CBI	Corning Glass Works	1940 Crystal Street Corning, New York
1200		Drake Manufacturing Company	1713 West Hubbard Street Chicago, Illinois
1390		Emerson Electric Mfg. Co.	1824 Washington Avenue St. Louis, Missouri
1653	CGM	Fenwall, Incorporated	Ashland, Mass.
1820	CGX	G. M. Laboratories, Inc.	4314-26 North Knox Avenue Chicago, Illinois
1881	CG	General Electric Company	840 S. Canal Street Chicago, Illinois

APPENDIX

LIST OF MANUFACTURERS

Code No.	Mfr.'s Prefix	Name	Address
2050	CGE	Guardian Electric Mfg. Company	1430 West Washington Blvd. Chicago 7, Illinois
2140	CHC	Hammarlund Mfg. Co., Inc.	460 West 34th Street New York, New York
2160	CHH	Hart and Hegeman Division	Arrow Hart and Hegeman Elec. Co. Hartford, Connecticut
2210	CHN	Heinemann Circuit Breaker Co.	939 Plug Street Trenton, New Jersey
2360	CIR	International Resistance Co.	401 North Broad Street Philadelphia, Pennsylvania
2410	CBU	Isolantite, Incorporated	10 Park Place New York, New York
2570	CFJ	E. F. Johnson Company	Waseca, Minnesota
2580	CJC	Howard B. Jones	2300 Wabansia Avenue Chicago, Illinois
2740	CKU	Kurman Electric Co., Inc.	3030 Northern Blvd. Long Island 1, New York
2920	CLF	Littlefuse, Incorporated	4757 North Ravenswood Avenue Chicago 40, Illinois
3090	CML	Meissner Mfg. Co.	Mt. Carmel, Illinois
3169	CMM	J. W. Miller, Inc.	5917 S. Main Los Angeles, California
3220	CNA	National Company, Inc.	61 Sherman Street Malden, Mass.
3230		The Nat'l Copper and Smelting Company	1862 E. 123rd Street South of Euclid Avenue Cleveland 6, Ohio
3240		National Fabricated Products	2650 Belden Avenue Chicago, Illinois
3260		National Insulations Company	2808 West Lake Street Chicago, Illinois
3410	COC	Oak Manufacturing Company	1260 Clybourn Avenue Chicago 10, Illinois
3450	COM	Ohmite Mfg. Co.	4835 West Flournoy Street Chicago, Illinois

APPENDIX

LIST OF MANUFACTURERS

Code No.	Mfr.'s Prefix	Name	Address
4030	CAN	Sangamo Electric Company	1935 Funk Street Springfield, Illinois
4170	CFW	F. W. Sickles Company	Box 920 Springfield 2, Mass.
4230	CPQ	Speer Resistor Corp.	St. Mary's, Pennsylvania
4250	CSF	Sprague Specialties Corp.	North Adams, Mass.
4310	CSD	Strithers Dunn Co.	1321 Arch Street Philadelphia, Pennsylvania
4420	CTE	Telephonics Corporation N. Y.	350 West 31st Street New York, New York
4450	CTH	Thordarson Elec. Mfg. Co.	500 West Huron Street Chicago, Illinois
4820	CAO	Ward Leonard Electric Co.	Mount Vernon, New York
4850		Watlow Electric Mfg. Co.	1320 North 23rd Street St. Louis, Missouri
4870	CW	Western Electric Co., Inc.	300 Central Kearny, New Jersey
4910	CV	Weston Elec. Instrument Corp.	Newark, New Jersey
4945		Edwin L. Wiegand Co.	7500 Thomas Blvd. Pittsburgh, Pennsylvania

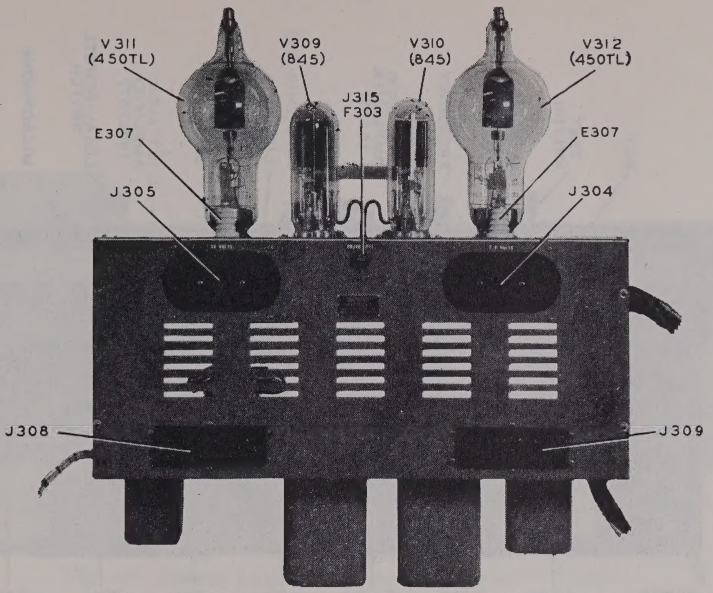


Fig. 49 Modulator and Audio Driver Unit

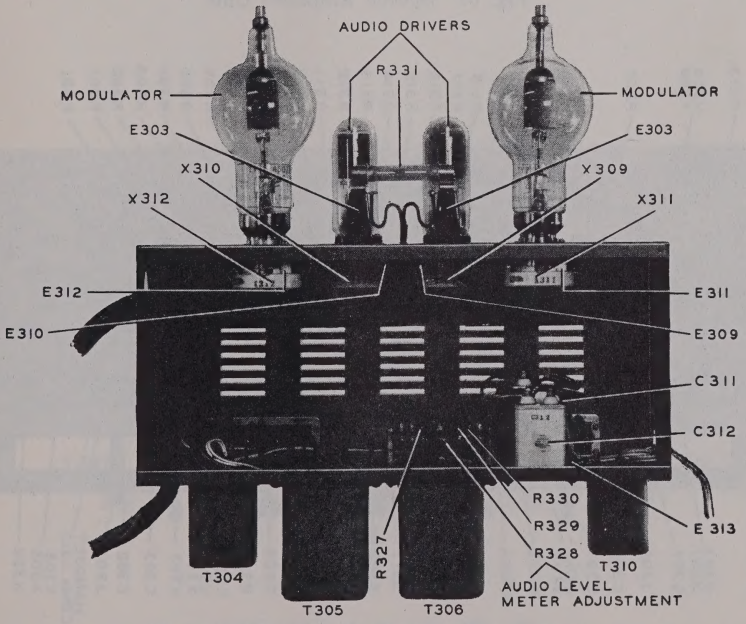


Fig. 50 Modulator and Audio Driver Unit
(Photo No. 8722)

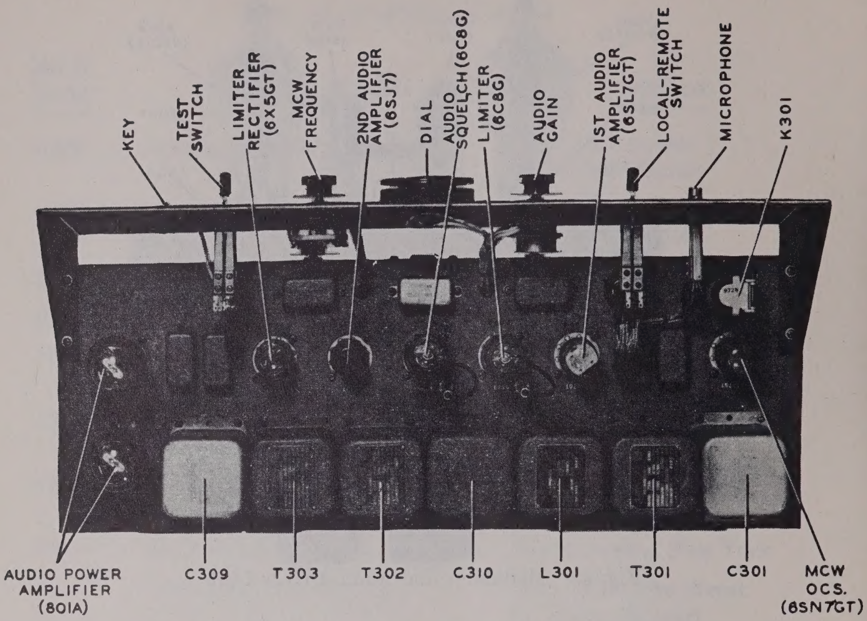


Fig. 51 Speech Amplifier Unit

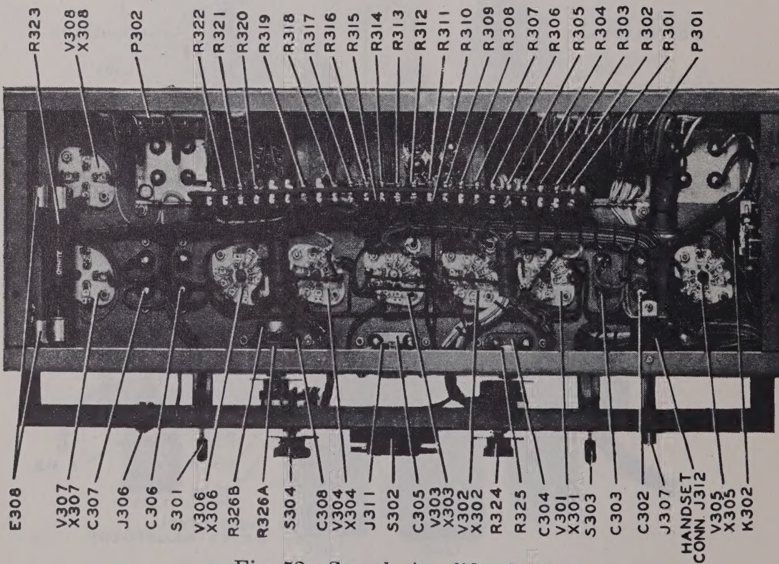


Fig. 52 Speech Amplifier Unit
(Photo No. 8723)

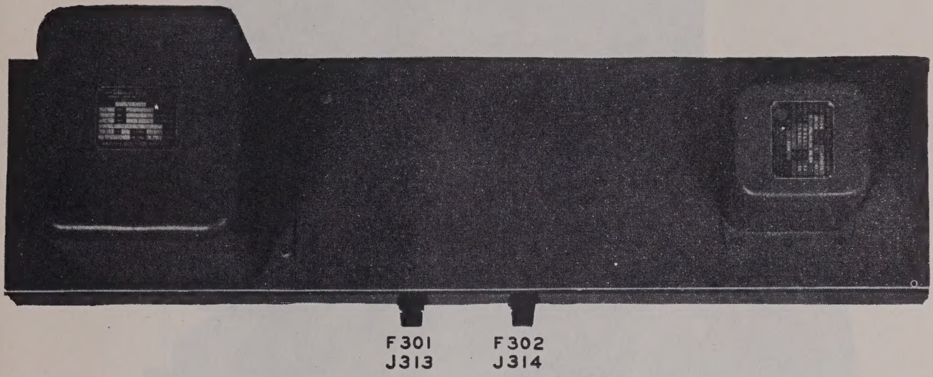


Fig. 53 Speech Amp. and Modulator Filament Supply

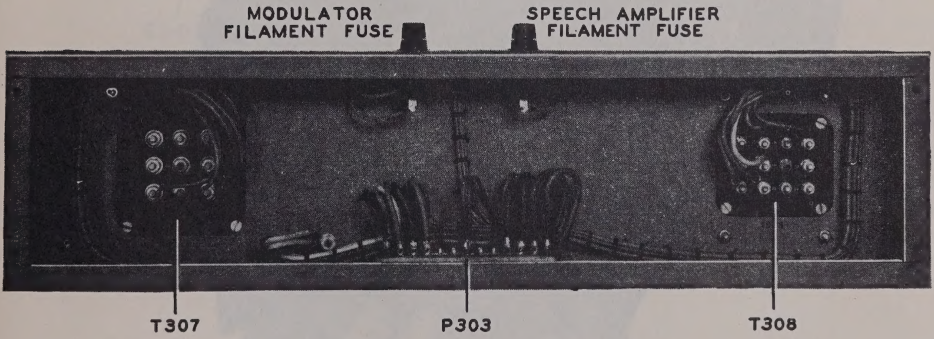
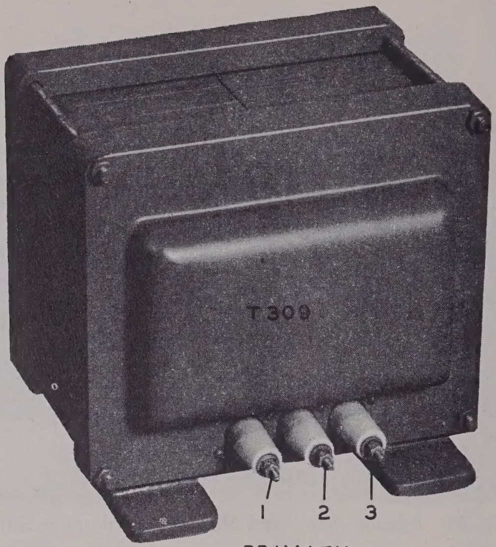
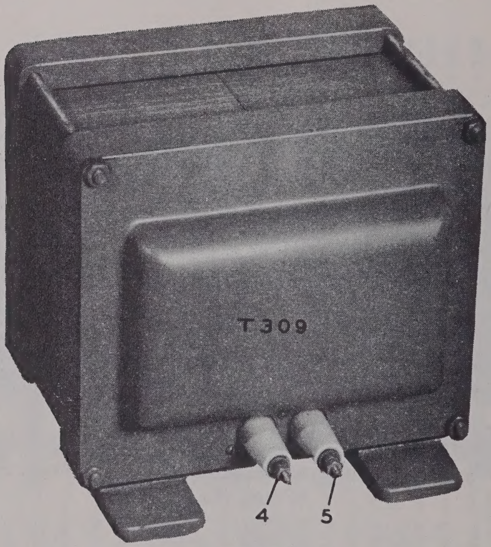


Fig. 54 Speech Amp. and Modulator Filament Supply
(Photo No. 8724)



PRIMARY



SECONDARY

Fig. 55 Modulation Transformer (Photo No. 8725)

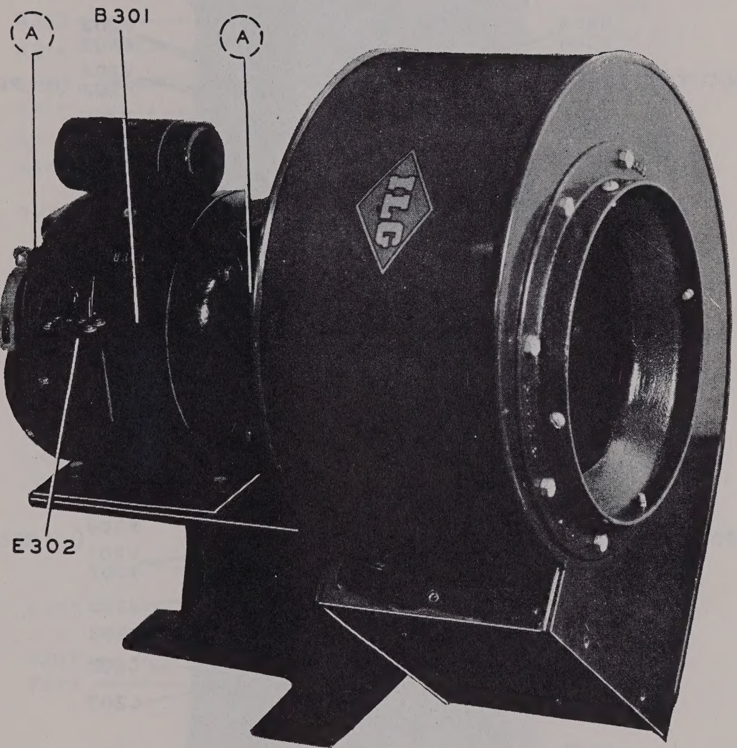


Fig. 56 Ventilating Blower (Photo No. 8726)

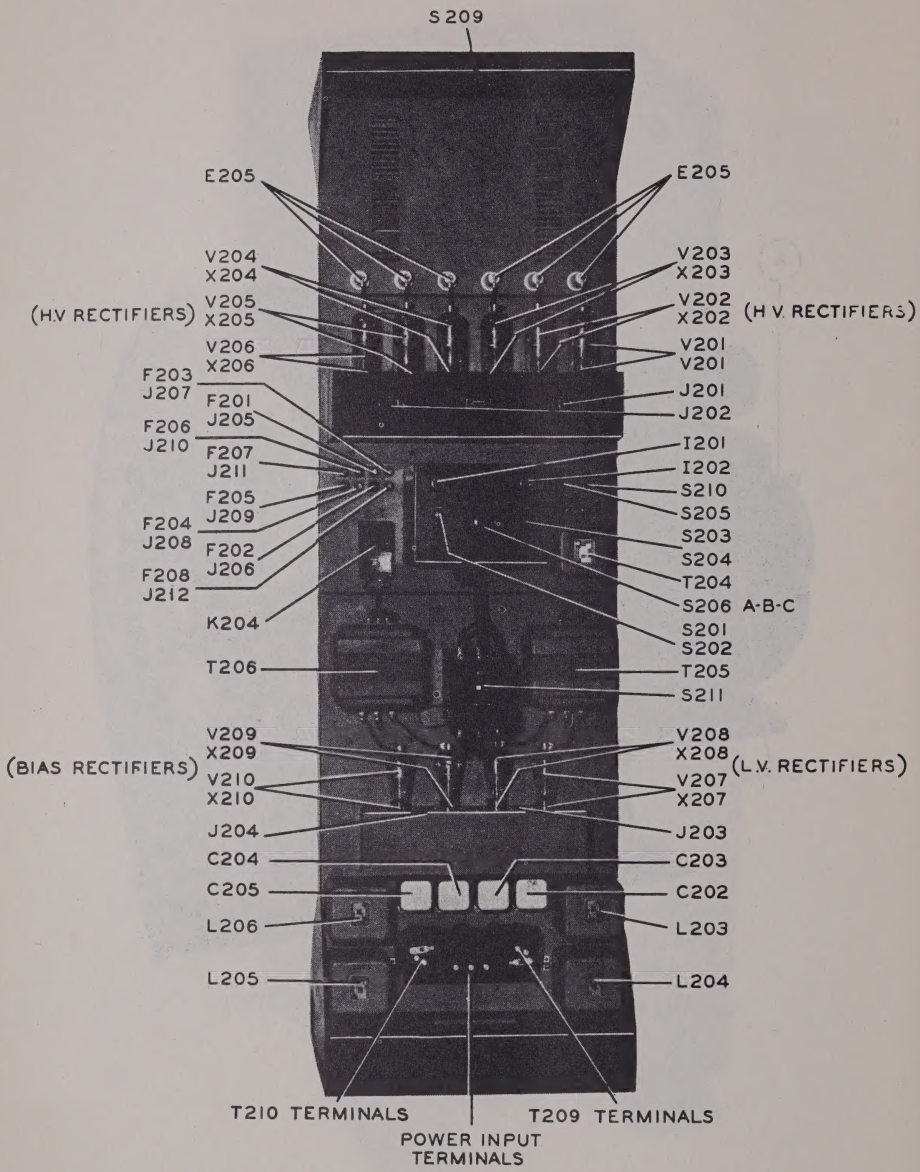


Fig. 57 Navy Type COL-20196 Rectifier Power Unit
(Photo No. 8727)

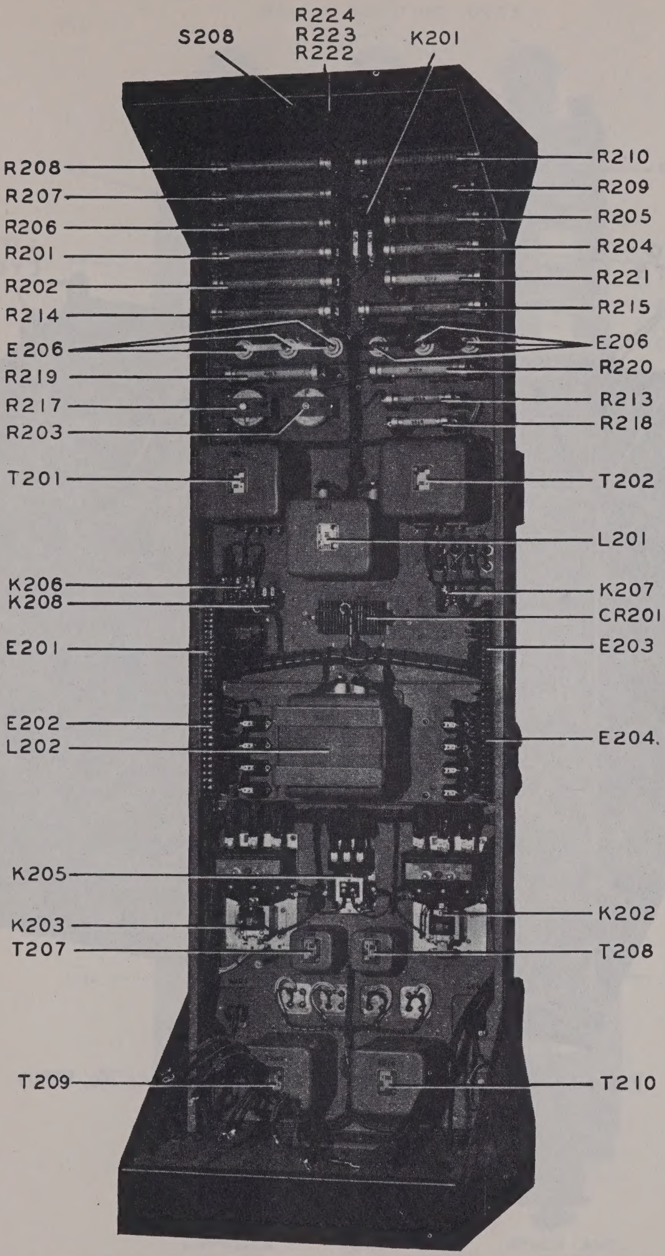


Fig. 58 Navy Type COL-20196 Rectifier Power Unit
(Photo No. 8729)

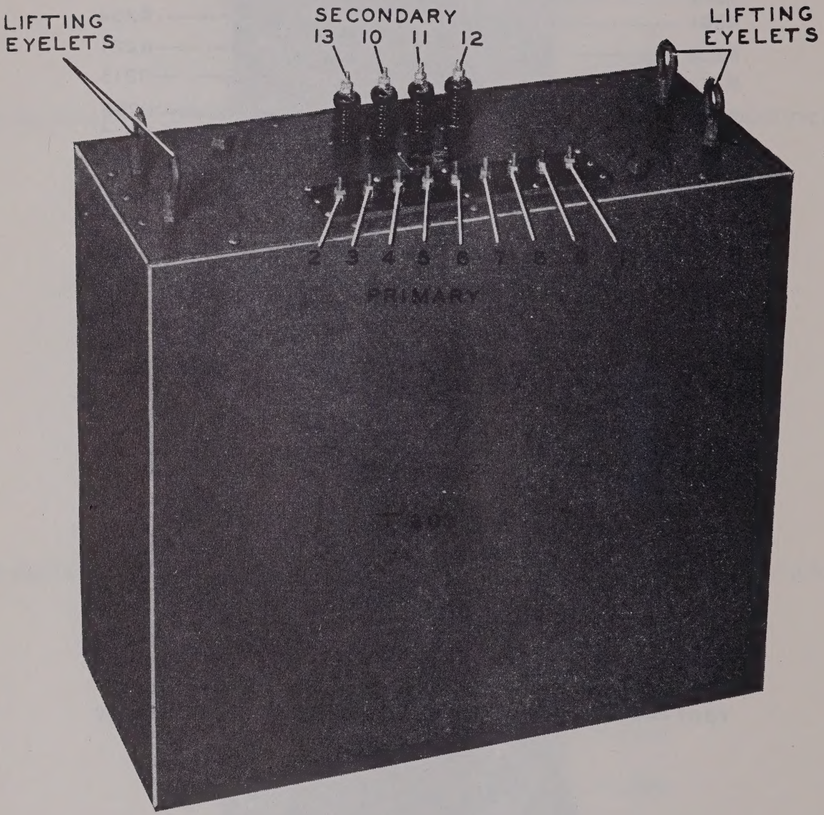


Fig. 59 High Voltage Power Transformer (Photo No. 8730)

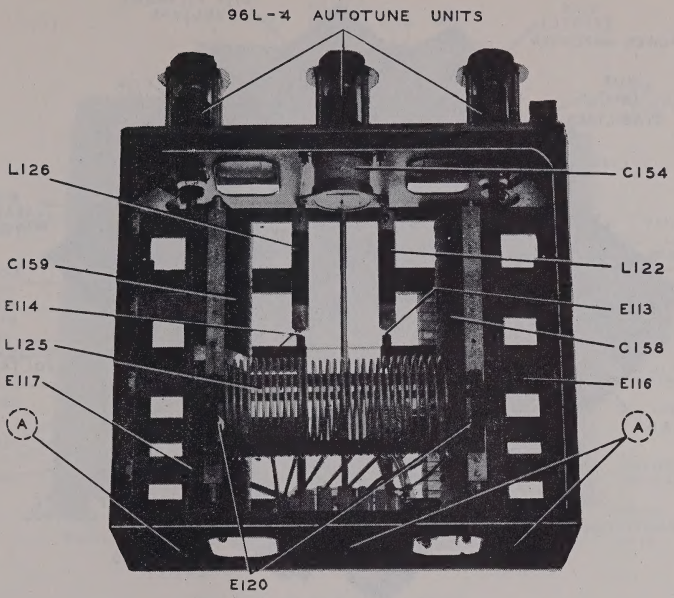


Fig. 60 Output Network Unit

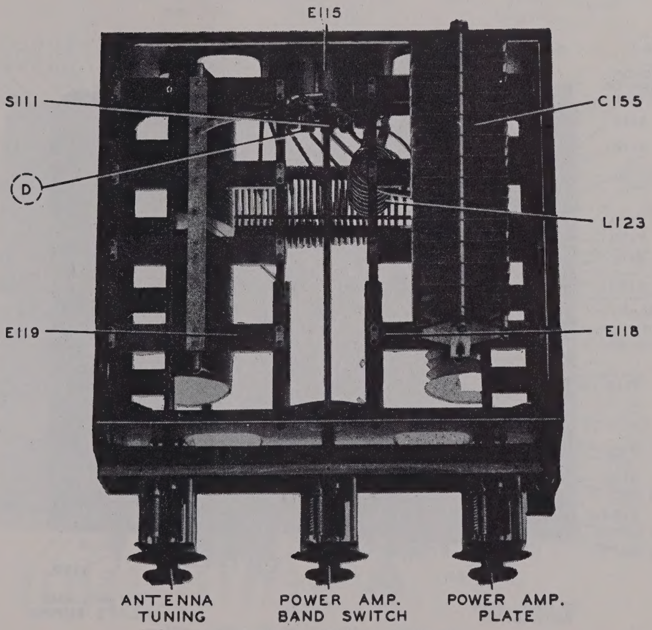


Fig. 61 Output Network Unit
(Photo No. 8731)

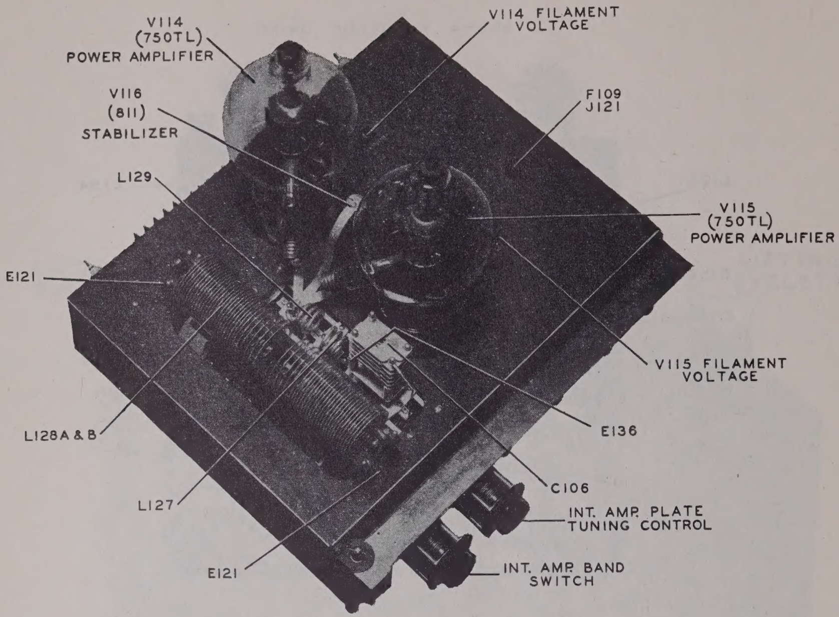


Fig. 62 Power Amplifier Unit

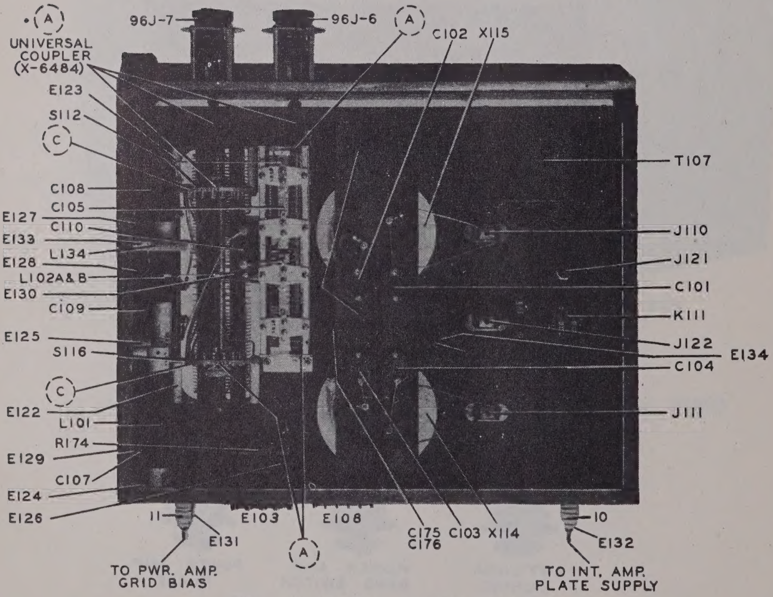


Fig. 63 Power Amplifier Unit
(Photo No. 8732)

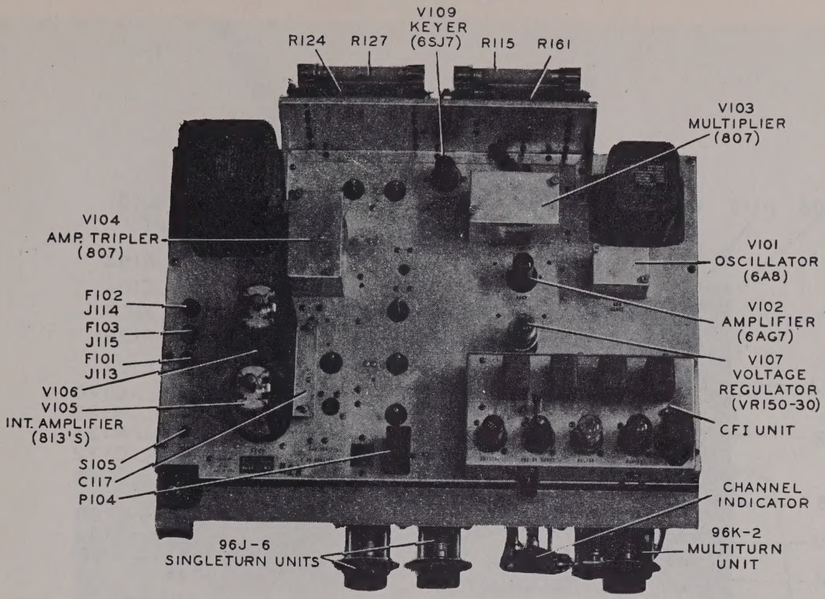


Fig. 64 R-F Exciter Unit

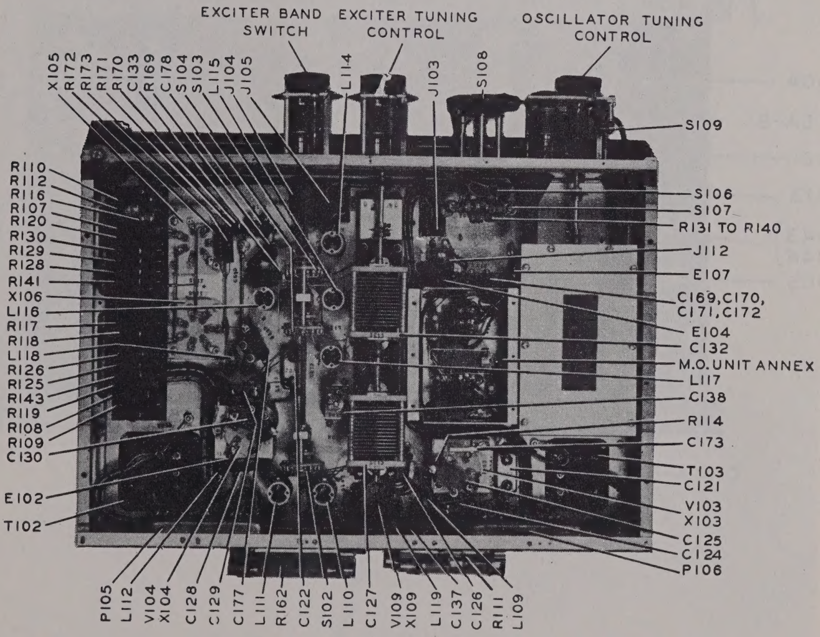


Fig. 65 R-F Exciter Unit
(Photo No. 8733)

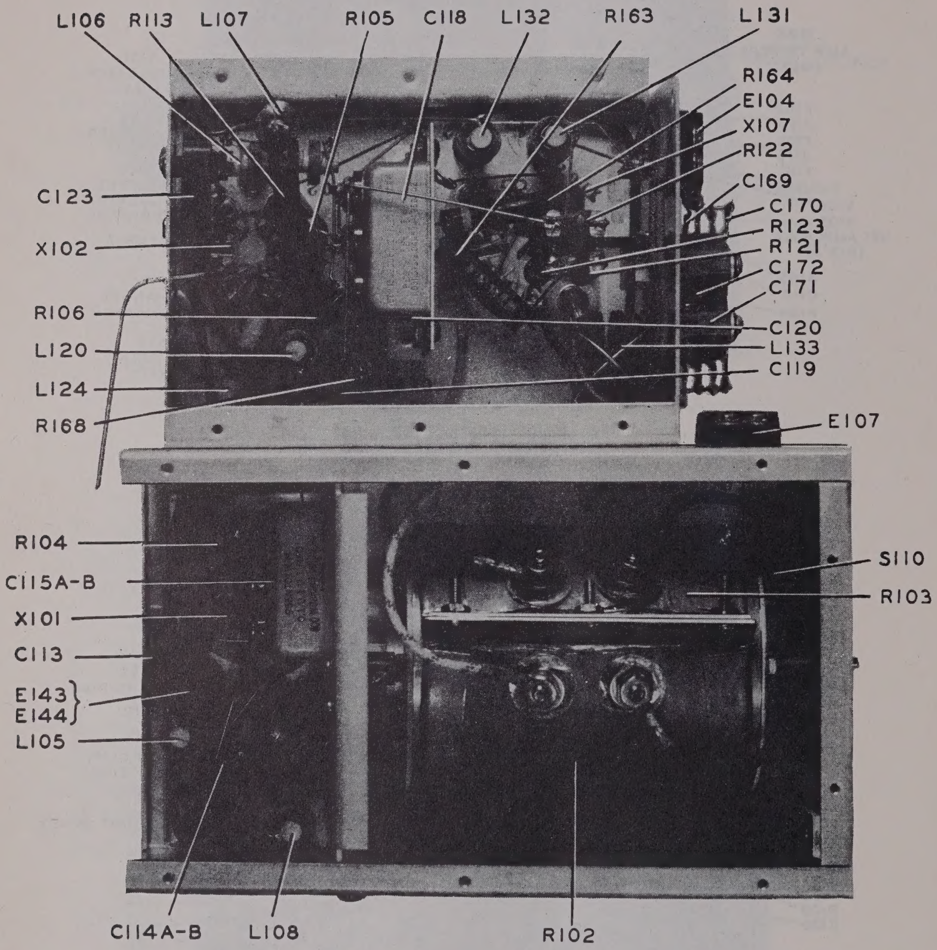


Fig. 66 MO and Annex Assembly (Photo No. 8747)

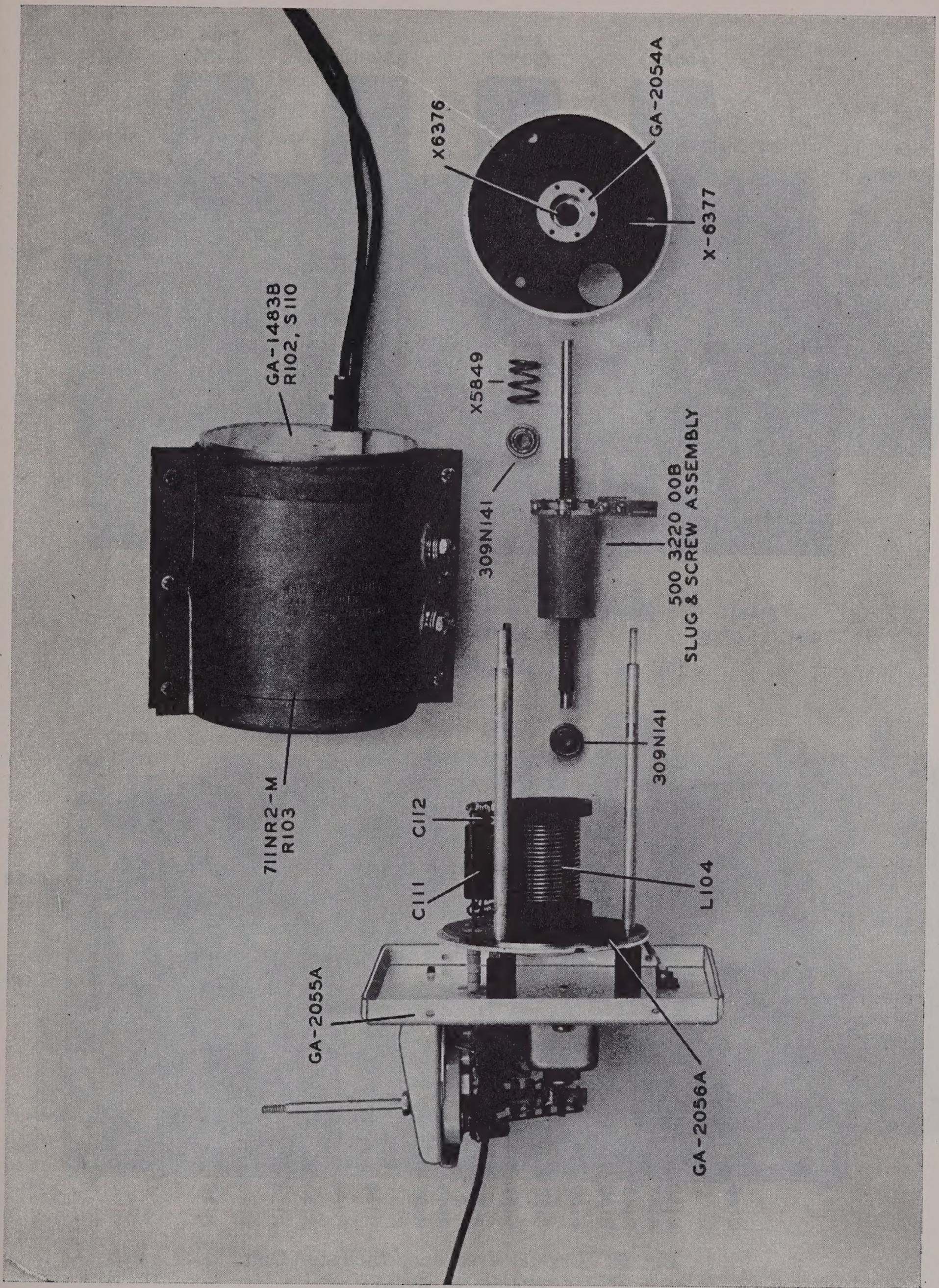


Fig. 67 MO Unit Dismantled (Photo No. 8734)

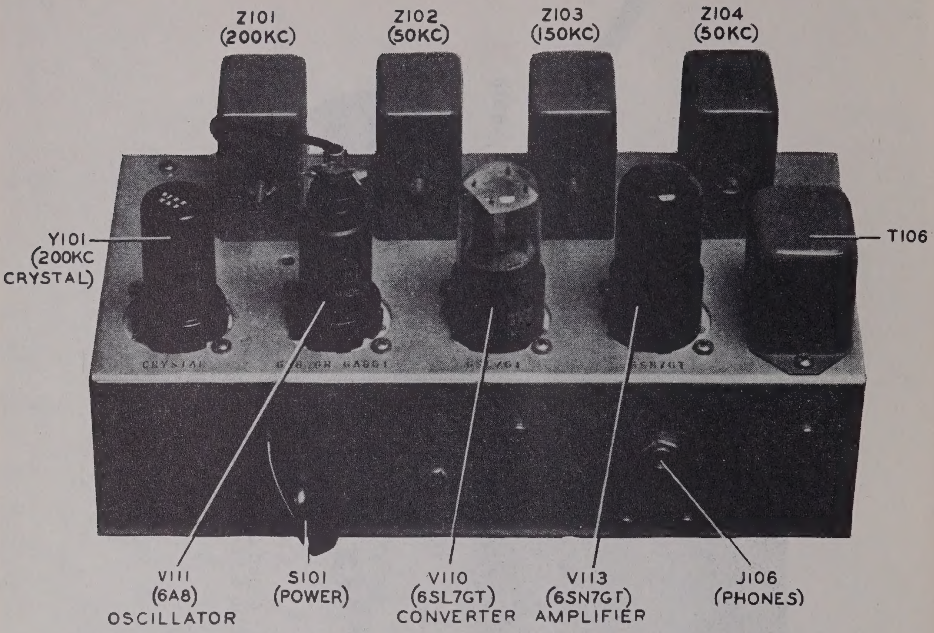


Fig. 68 Crystal Frequency Indicator Unit

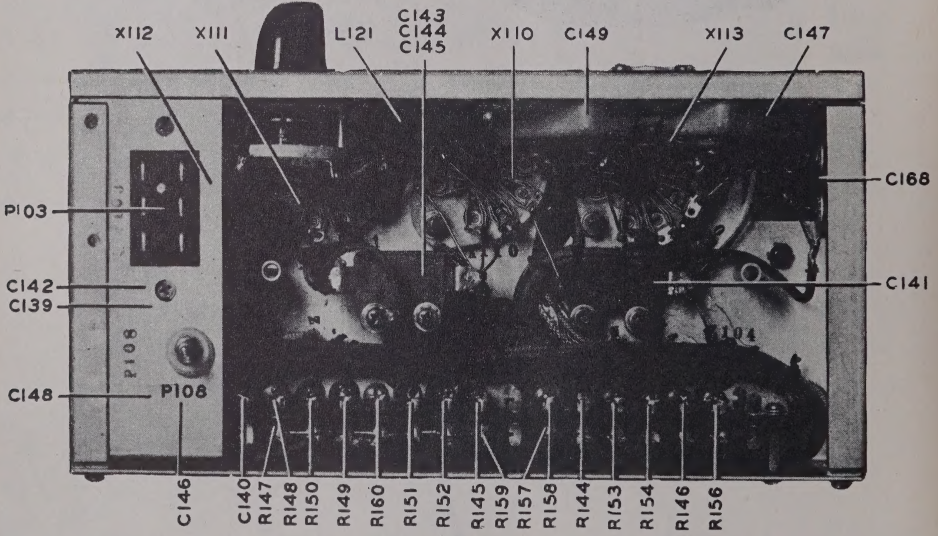


Fig. 69 Crystal Frequency Indicator Unit
(Photo No. 8735)

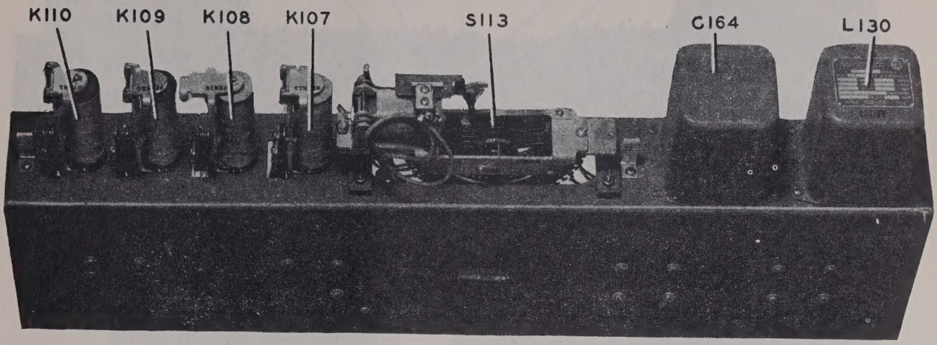


Fig. 70 Autotune Control Unit

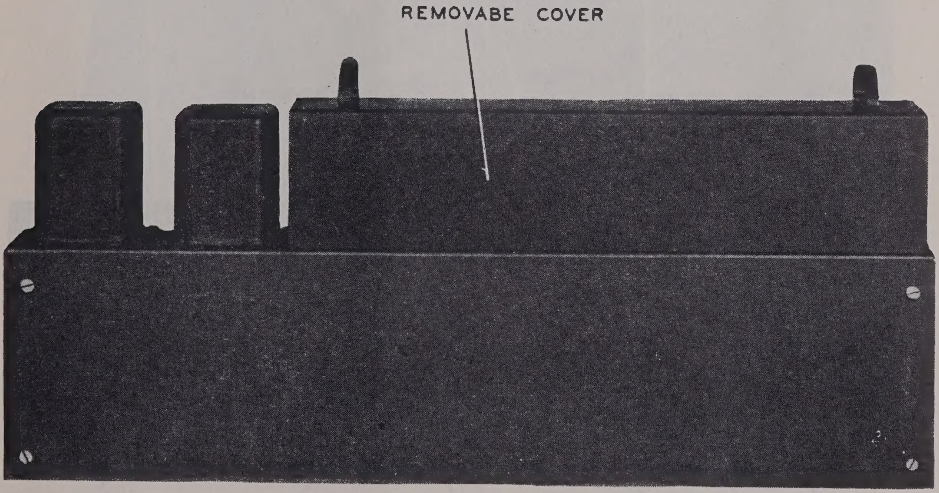


Fig. 71 Autotune Control Unit
(Photo No. 8736)

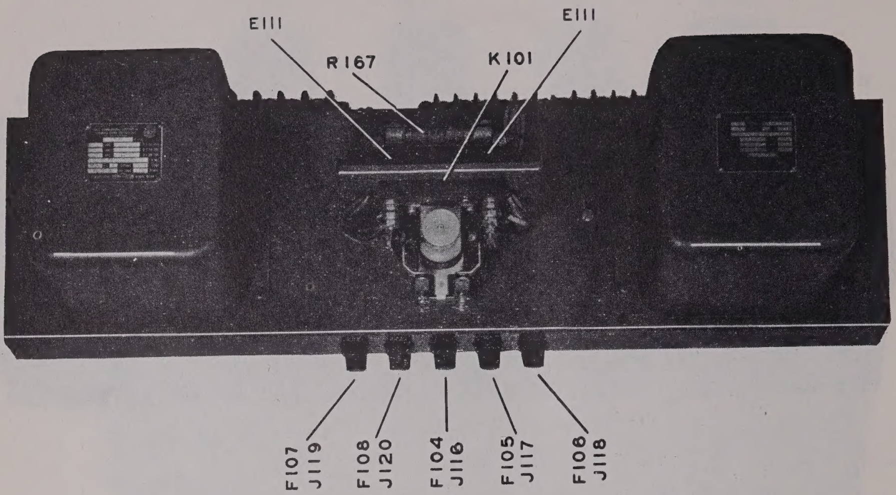


Fig. 72 Power Amplifier Filament Supply

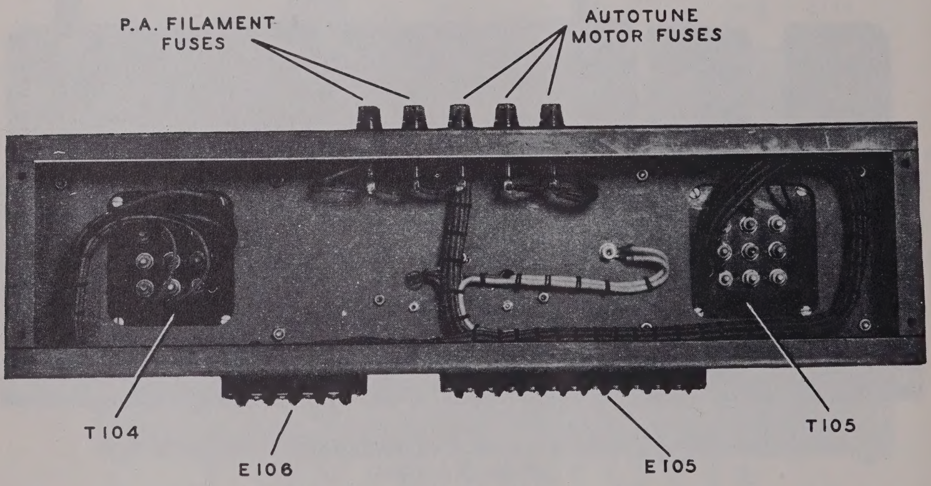


Fig. 73 Power Amplifier Filament Supply
(Photo No. 8738)

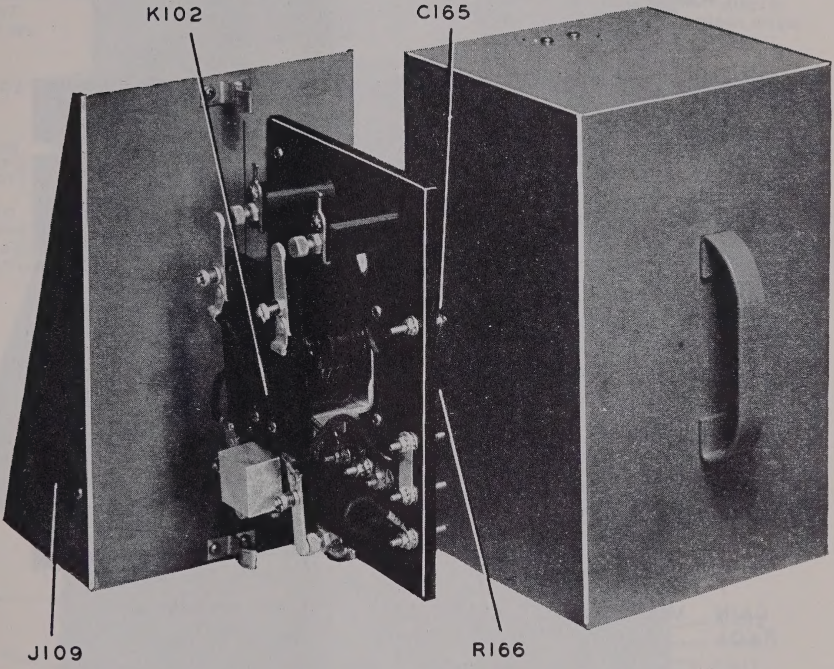


Fig. 74 Phone-CW Relay (Photo No. 8739)

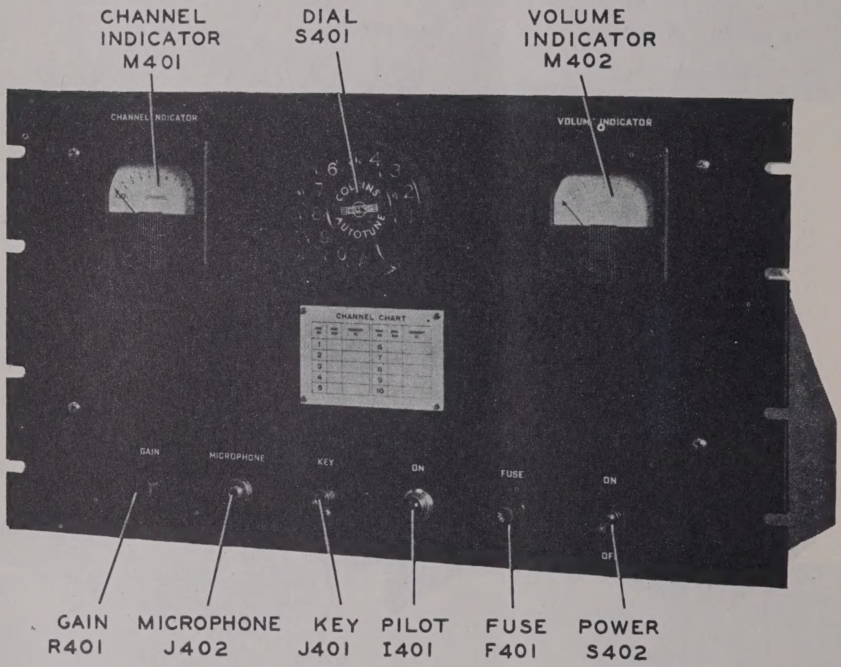


Fig. 75 Navy Type COL-23351 Remote Control Unit (Photo No. 8740)

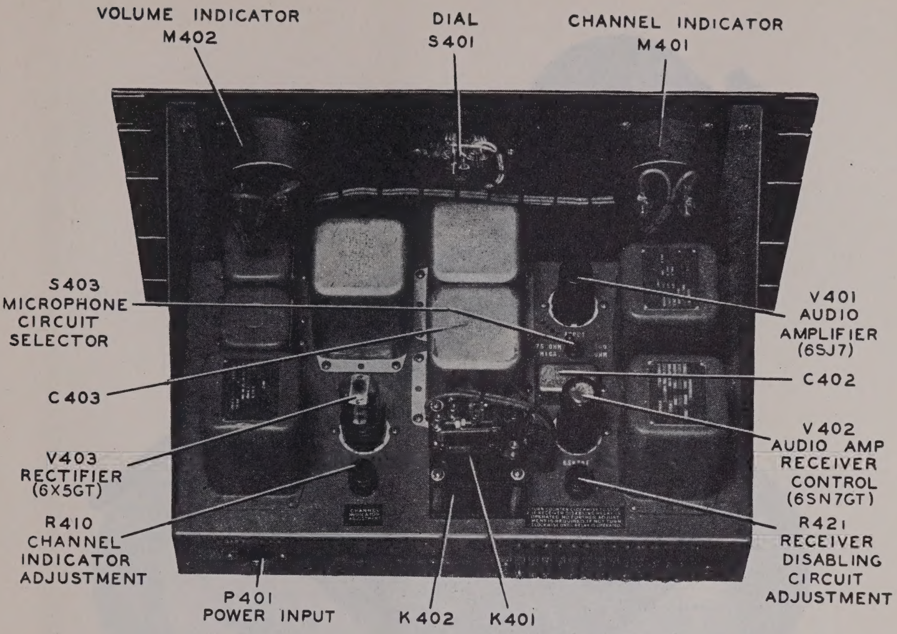


Fig. 76 Navy Type COL-23351 Remote Control Unit

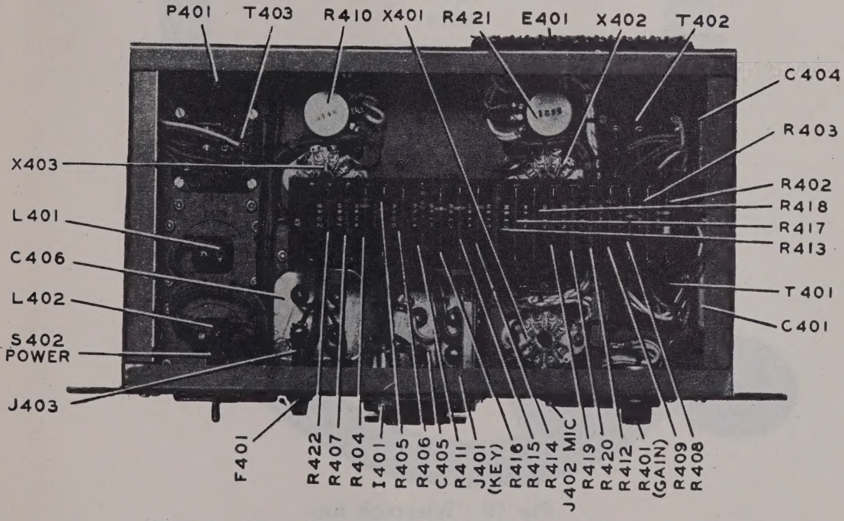


Fig. 77 Navy Type COL-23351 Remote Control Unit
(Photo No. 8743)

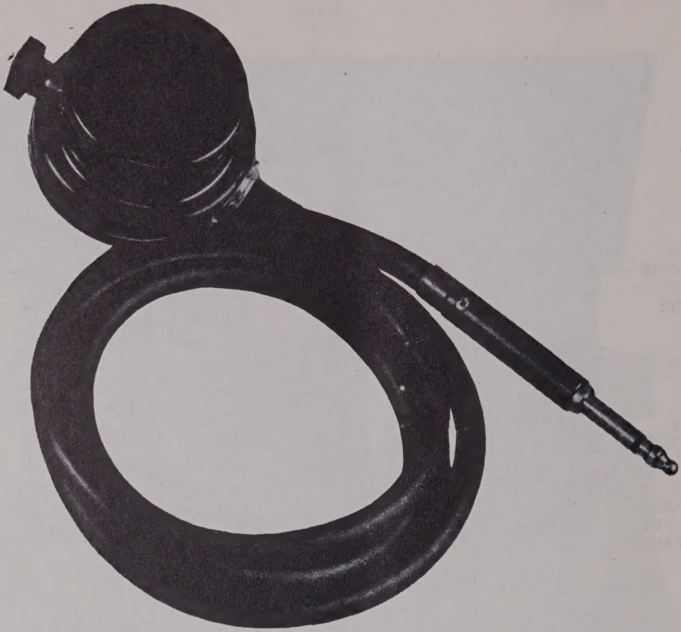


Fig. 78 Carbon Microphone

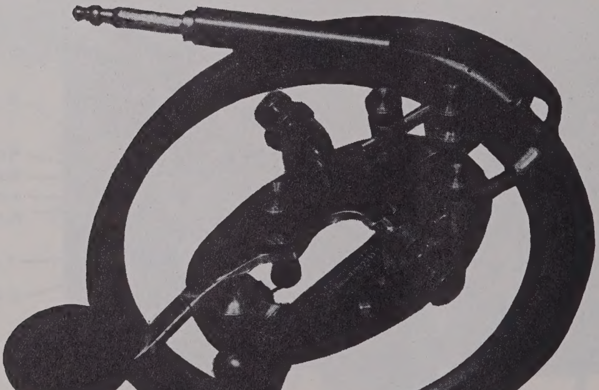


Fig. 79 Telegraph Key
(Photo No. 8744)

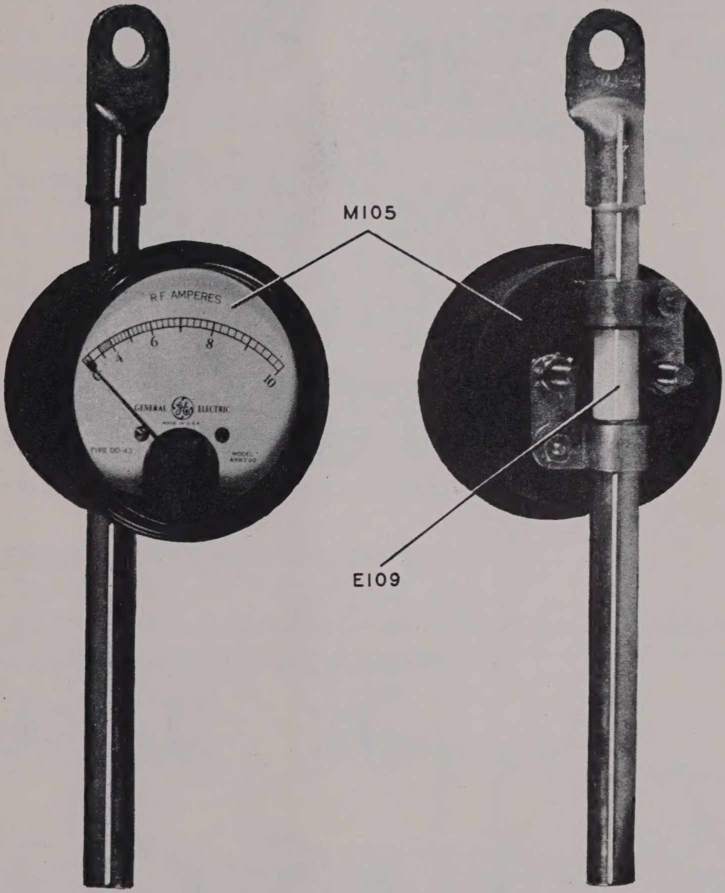


Fig. 80 Antenna Ammeter (Photo No. 8746)

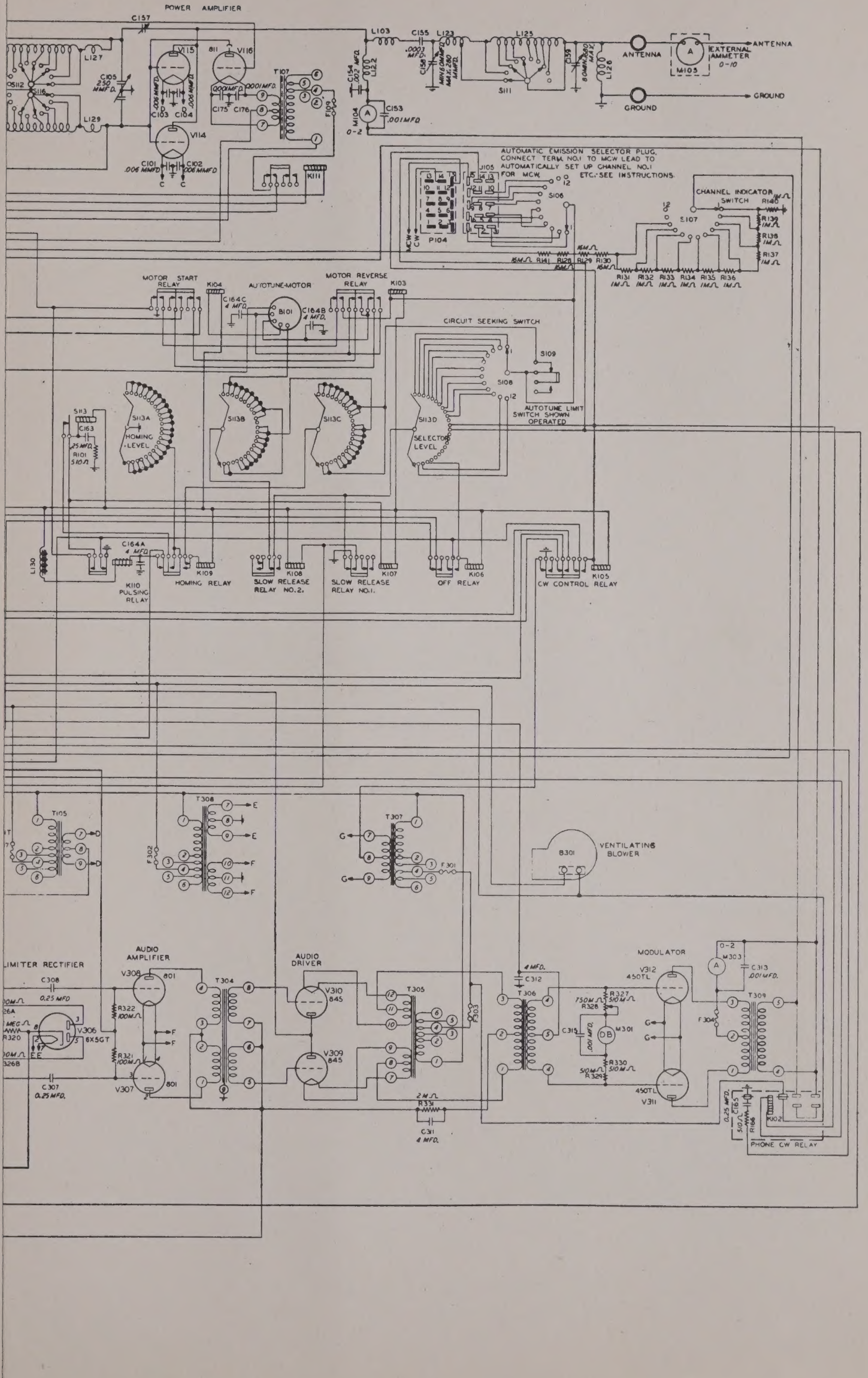


Fig. 81 TDH Complete Schematic Diagram
(Dwg. No. 500 3719 00F)

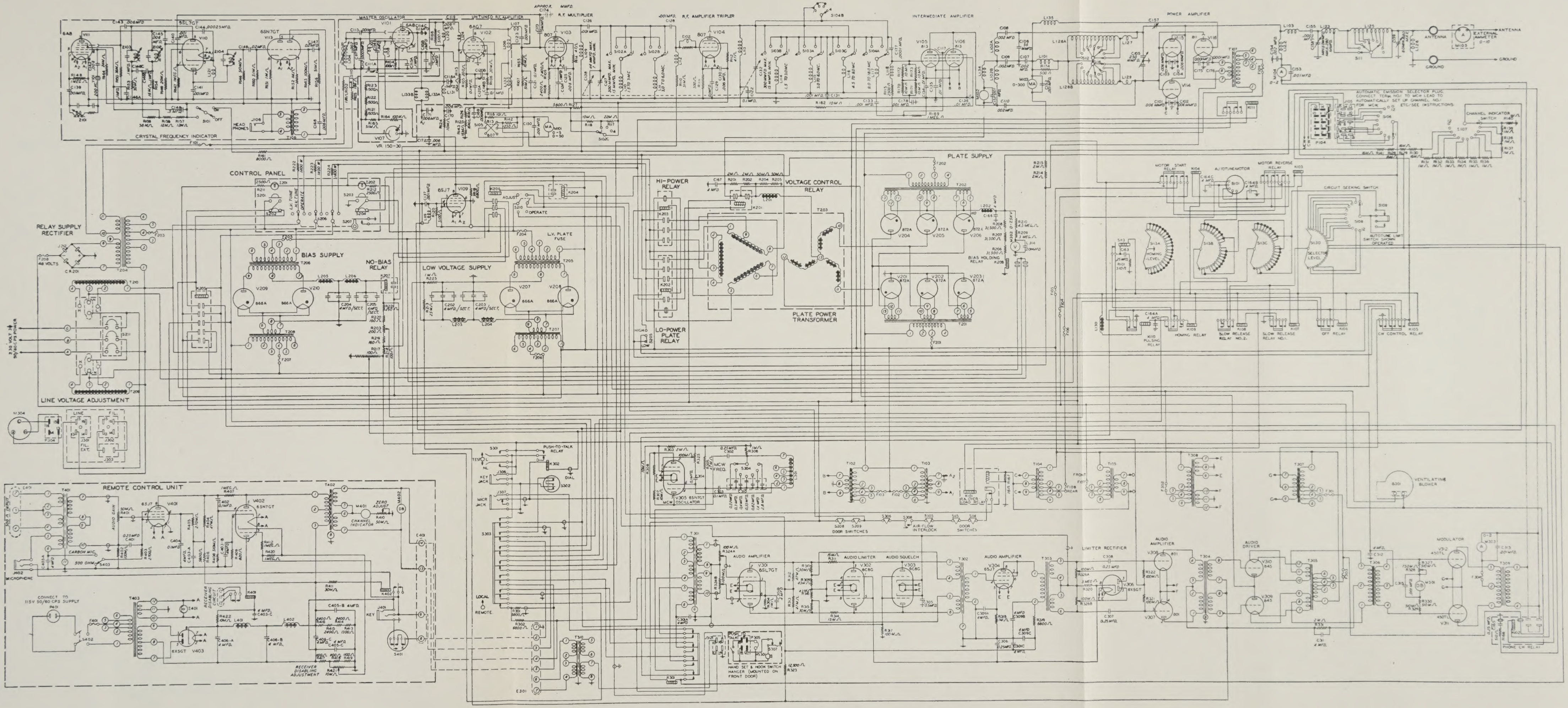


Fig. 81 TDH Complete Schematic Diagram
(Dwg. No. 500 3719 00F)

Fig. 81 TDH Complete Schematic Diagram
(Dwg. No. 500 3719 00F)

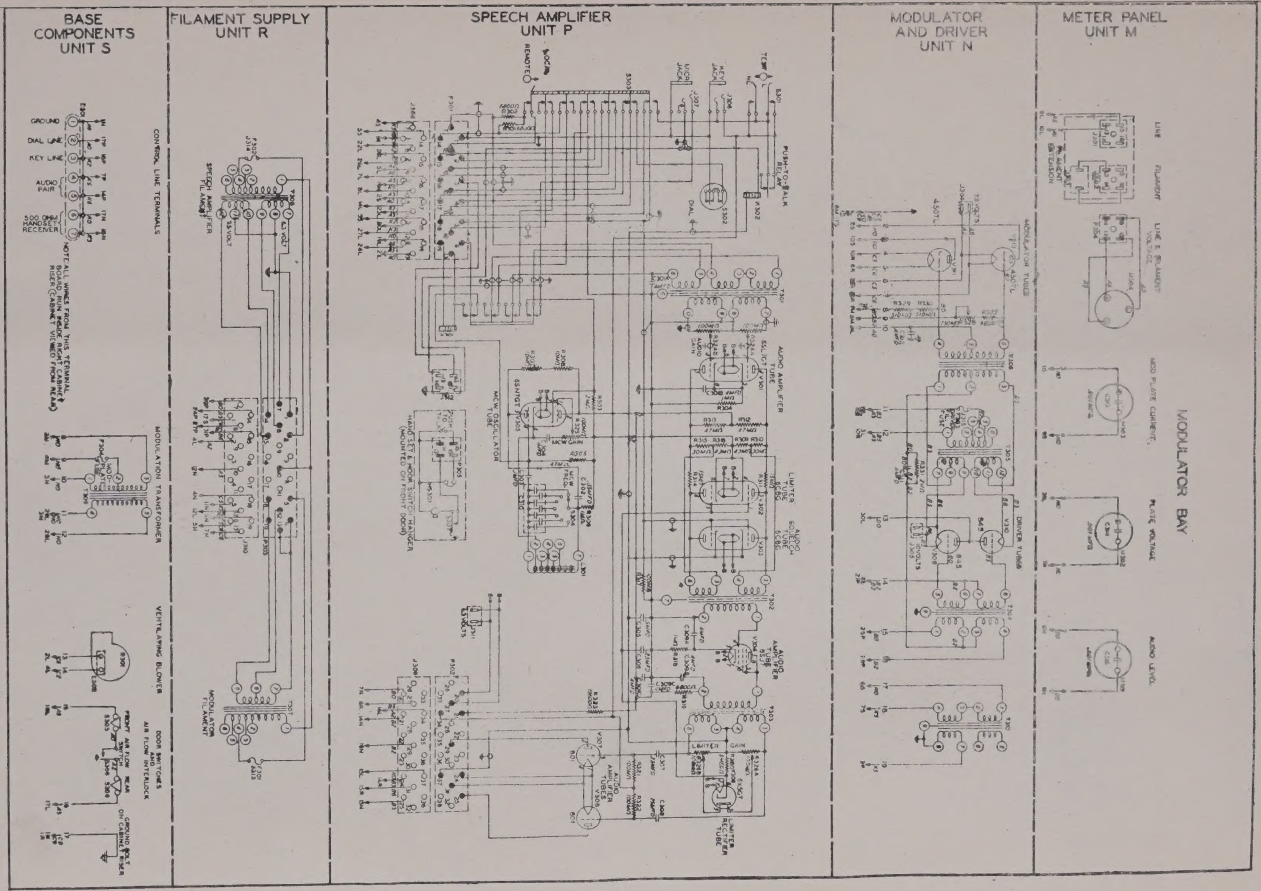


Fig. 82 TDH Cabling Schematic Diagram
(Dwg. No. 500 0512 00F)

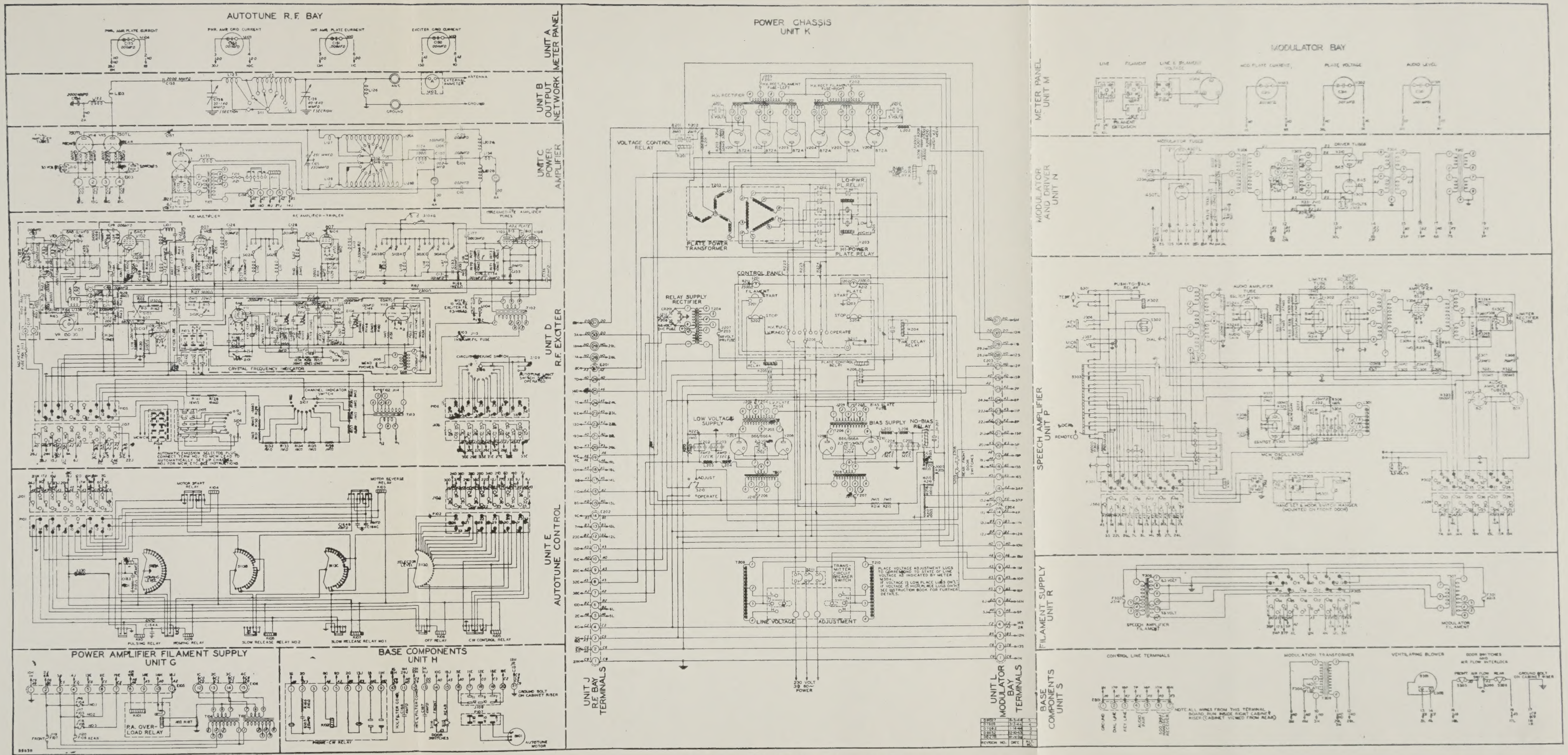


Fig. 82 TDH Cabling Schematic Diagram
(Dwg. No. 500 0512 00F)

Fig. 82 TDH Cabling Schematic Diagram
(Dwg. No. 500 0512 00F)

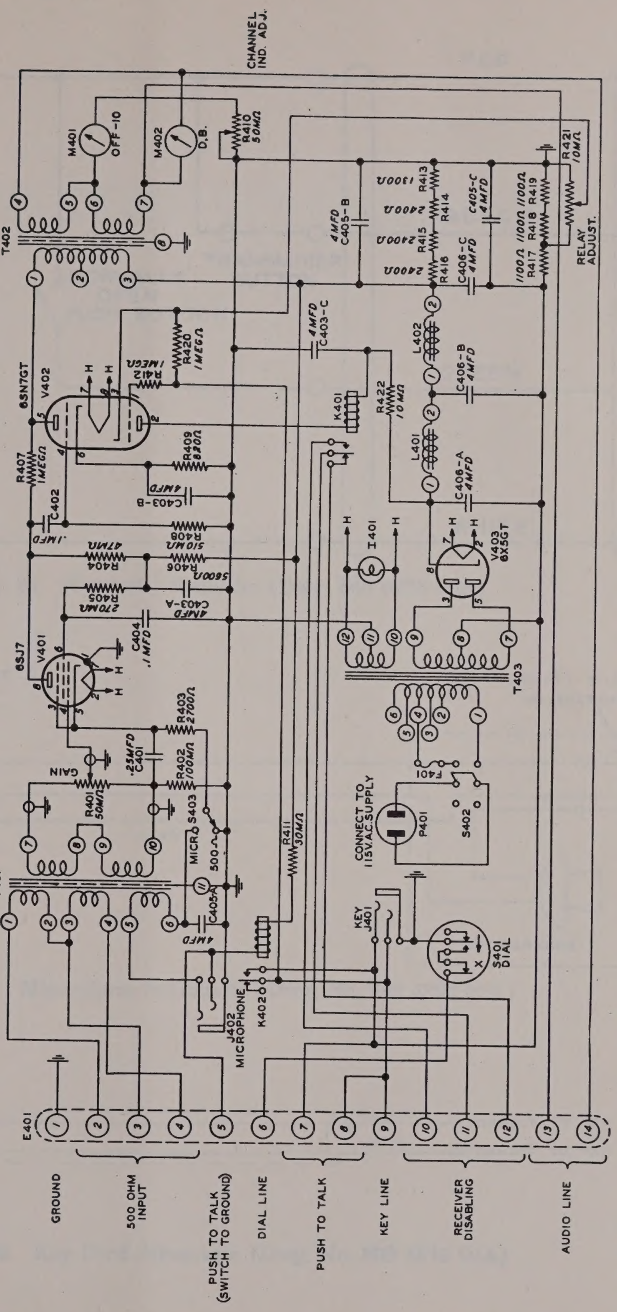


Fig. 83 Remote Control Unit Schematic (Dwg. No. 1540B)

Fig. 83 Remote·Control Unit Schematic (Dwg. No. 1540B)

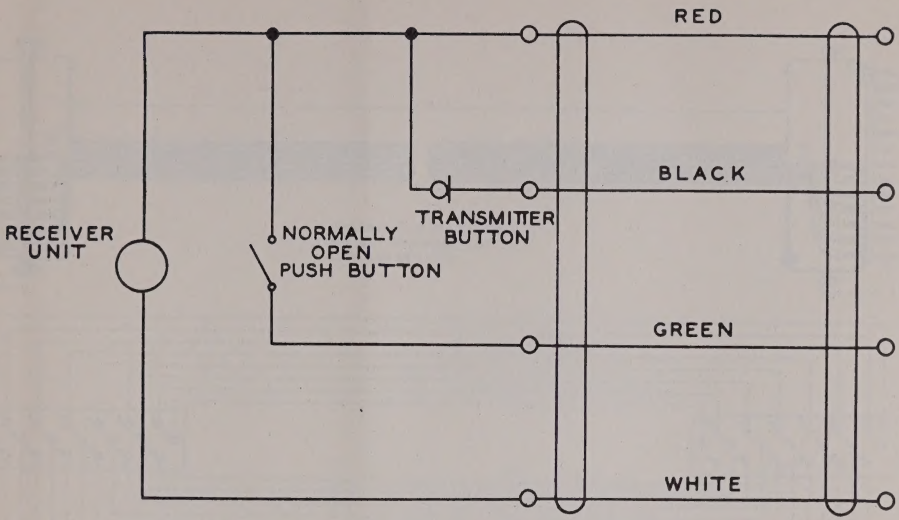


Fig. 84 Handset Schematic (Dwg. 500 0275 00A)

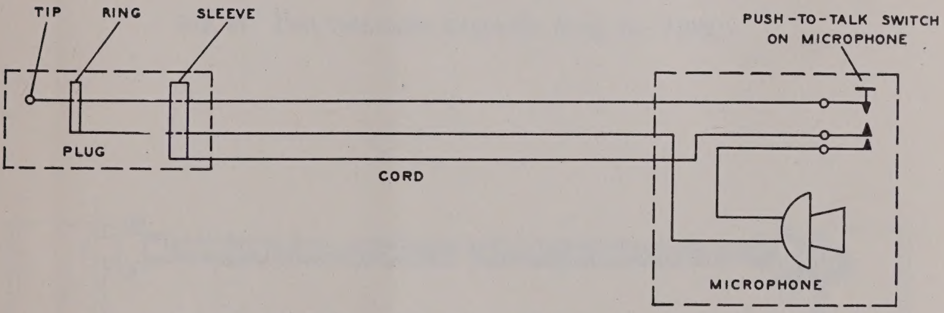


Fig. 85 Microphone Schematic (Dwg. No. 500 4393 00A)

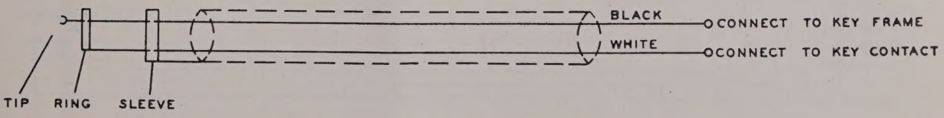
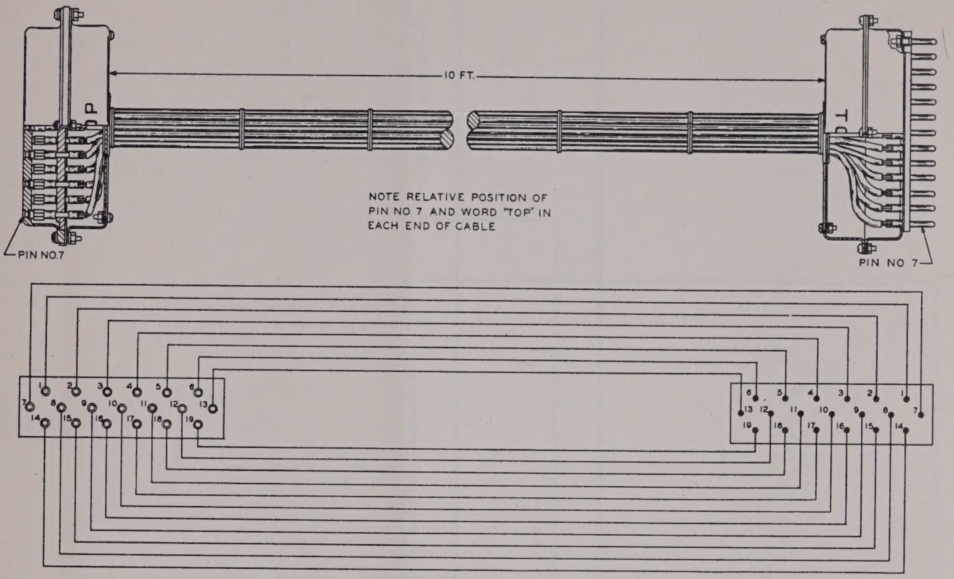


Fig. 86 Key Cord Schematic (Dwg. No. 500 4375 00A)



NOTE RELATIVE POSITION OF PIN NO 7 AND WORD "TOP" IN EACH END OF CABLE

Fig. 87 Unit Test Cable Assembly (Dwg. No. 1198C)

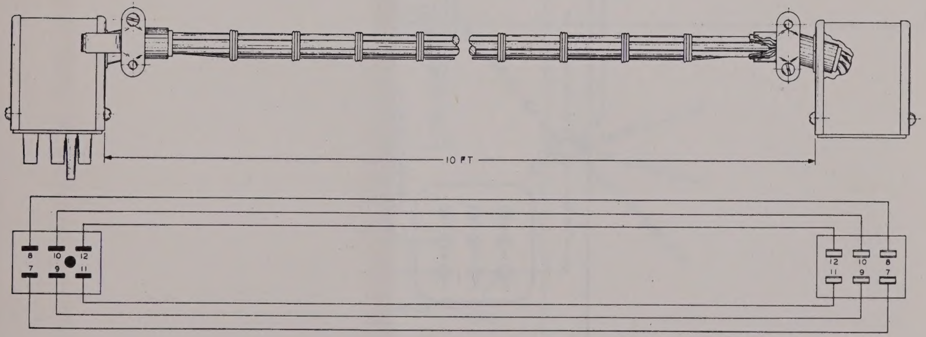


Fig. 88 CFI Test Cable Assembly (Dwg. No. 500 3999 00B)

m

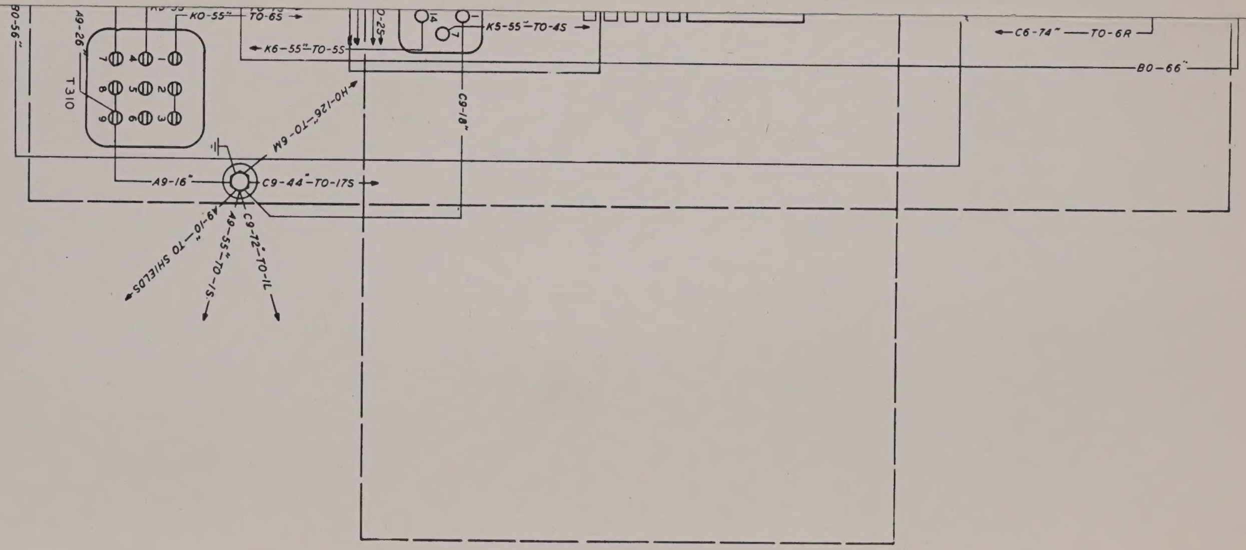


Fig. 89 Modulator and Audio Driver Unit Practical Wiring Diagram
(Dwg. No. 500 3943 00D)

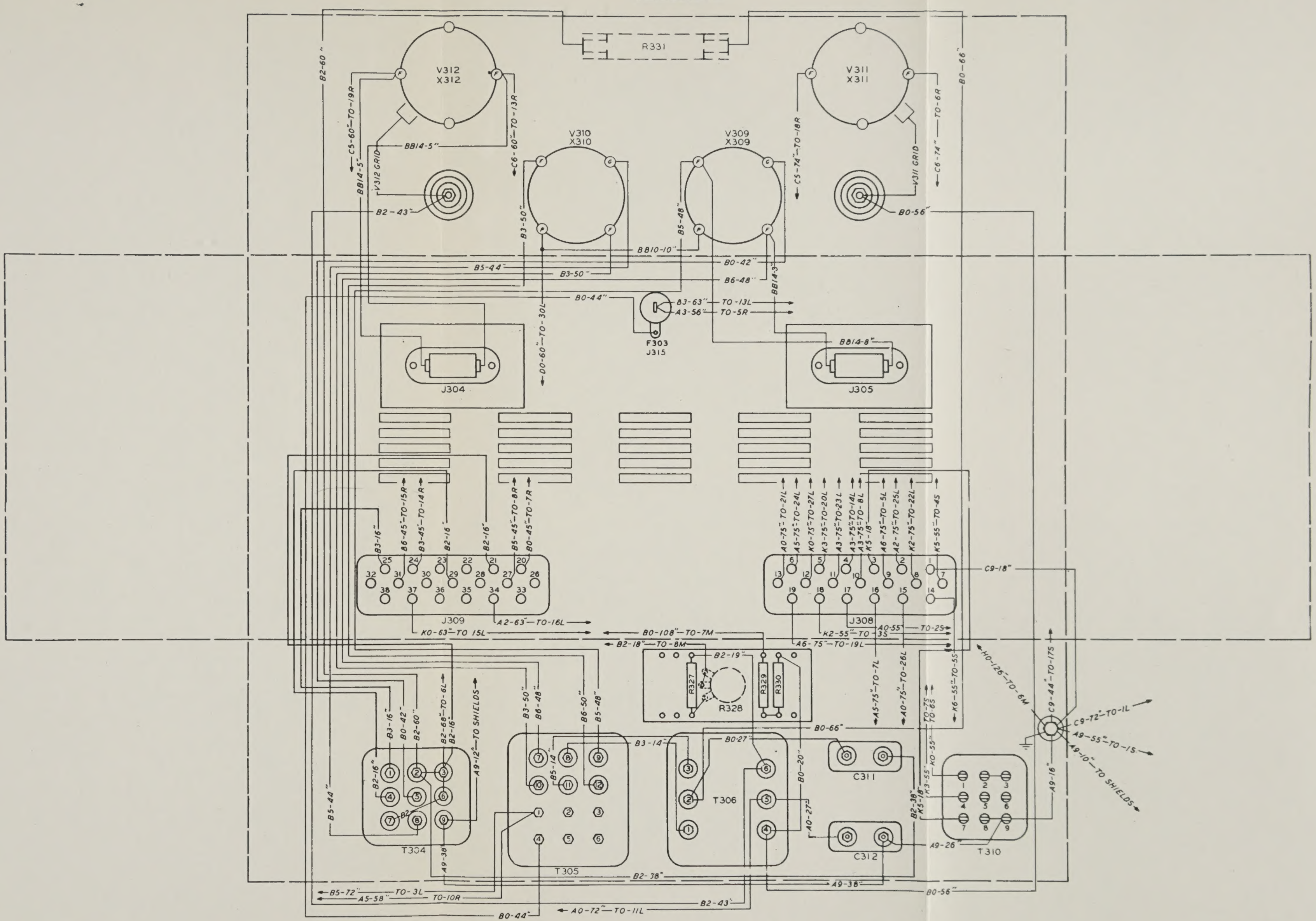


Fig. 89 Modulator and Audio Driver Unit Practical Wiring Diagram
(Dwg. No. 500 3943 00D)

Fig. 89 Modulator and Audio Driver Unit Practical Wiring Diagram
(Dwg. No. 500 3943 00D)

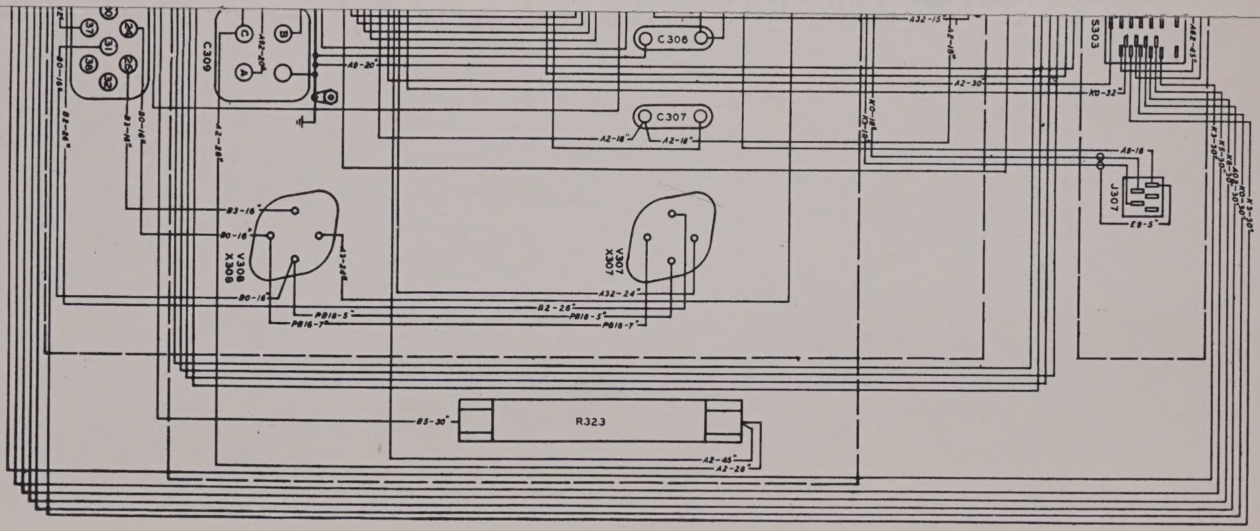


Fig. 90 Speech Amplifier Unit Practical Wiring Diagram
(Dwg. No. 500 1501 00D)

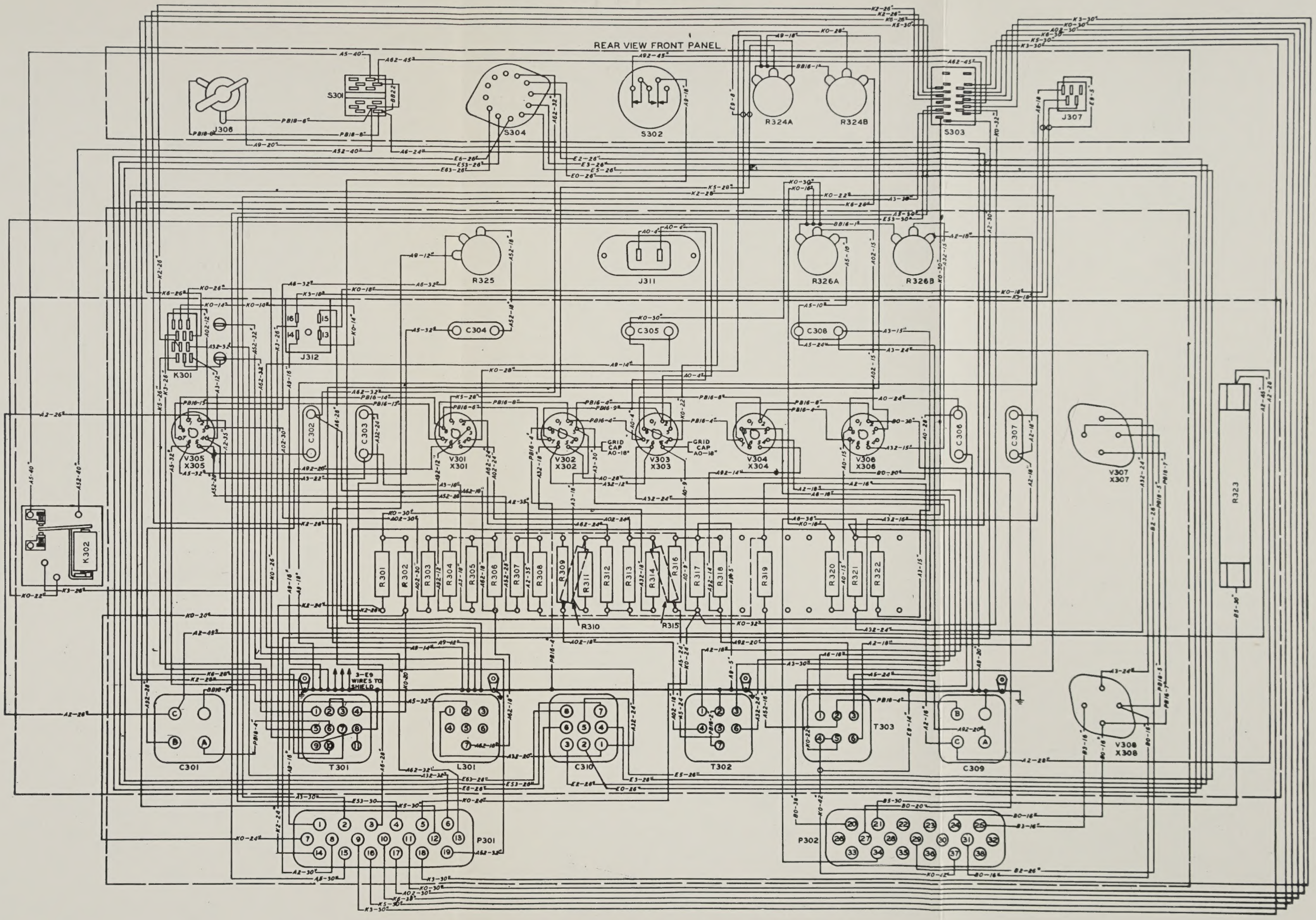


Fig. 90 Speech Amplifier Unit Practical Wiring Diagram
(Dwg. No. 500 1501 00D)

Fig. 90 Speech Amplifier Unit Practical Wiring Diagram
(Dwg. No. 500 1501 00D)

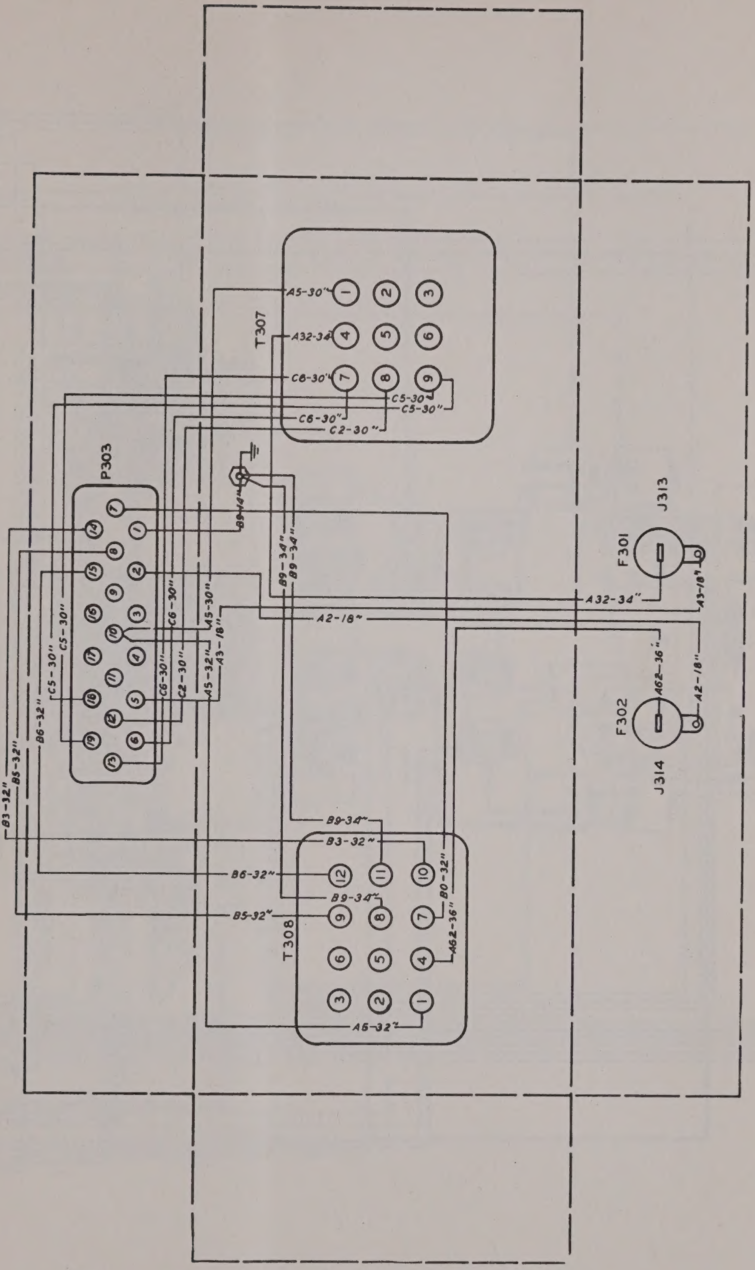


Fig. 91 Filament Supply Unit Practical Wiring Diagram (Dwg. No. 500 1538 00B)

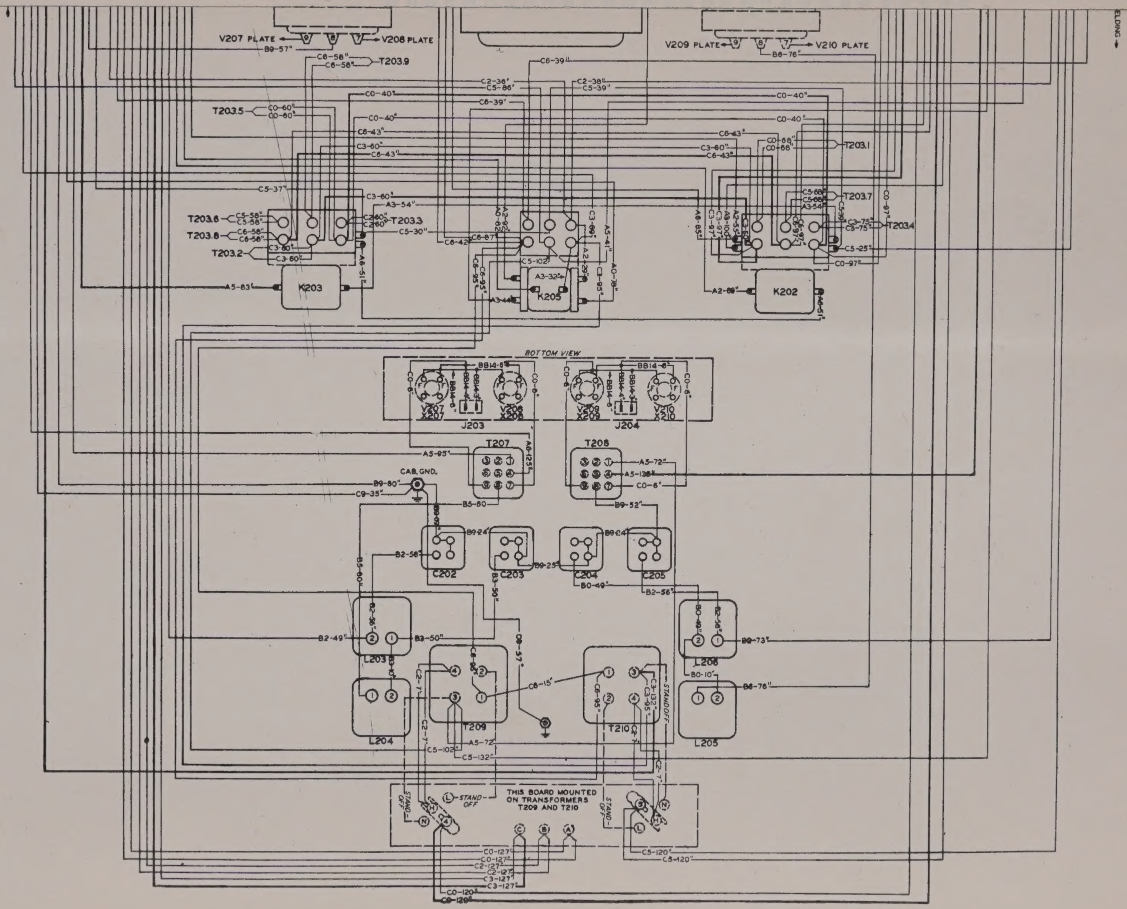


Fig. 92 Navy Type COL-20196 Rectifier Power Unit
(Dwg. No. 500 9018 00F)

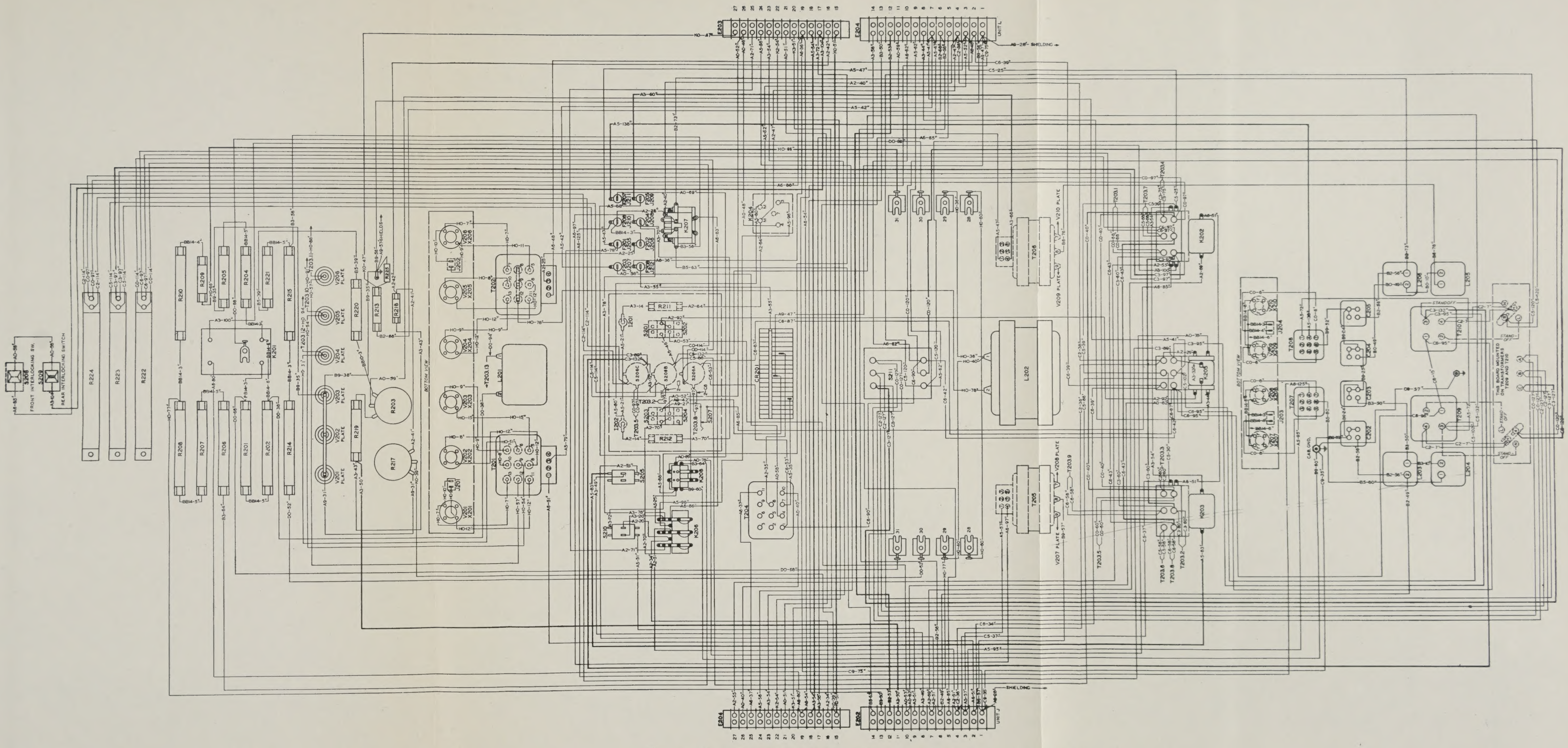


Fig. 92 Navy Type COL-20196 Rectifier Power Unit
(Dwg. No. 500 9018 00F)

Fig. 92 Navy Type COL-20196 Rectifier Power Unit
(Dwg. No. 500 9018 00F)

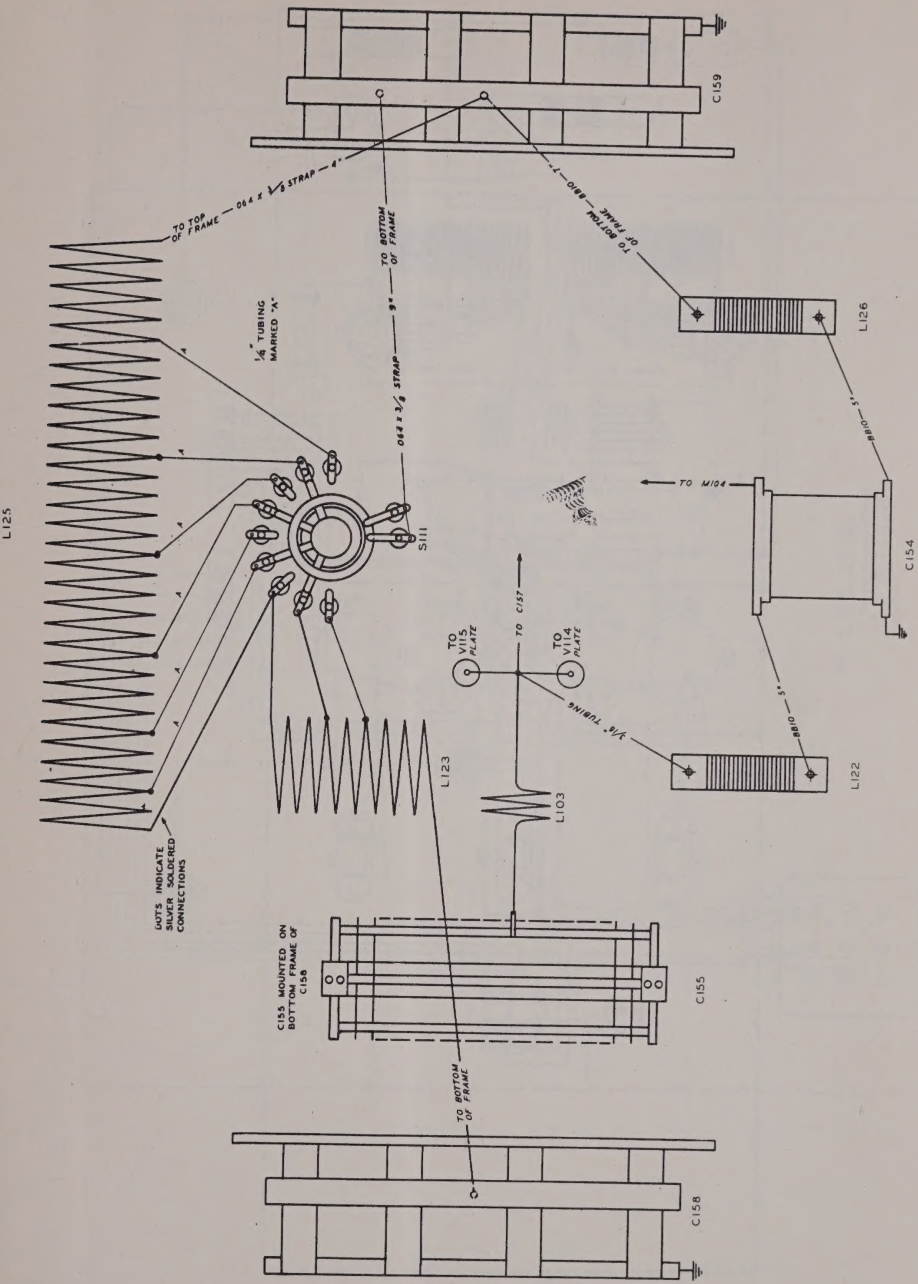

L125
C159
TO TOP OF FRAME — .064 x 3/8 STRAP — 4"
TO BOTTOM OF FRAME — 3" — .064 x 3/8 STRAP
1/4" TUBING MARKED "A"
A
TO BOTTOM OF FRAME — BB10 — 7"
L126
BB10 — 5"
TO M104
C154
S111
TO C157
TO V115 PLATE
TO V114 PLATE
3/16" TUBING
BB10 — 5"
L122
L123
L103
DOTS INDICATE SILVER SOLDERED CONNECTIONS
C155 MOUNTED ON BOTTOM FRAME OF C158
C155
TO BOTTOM OF FRAME
C158

Fig. 93 Output Network Unit Practical Wiring Diagram (Dwg. No. 500 2826 00C)

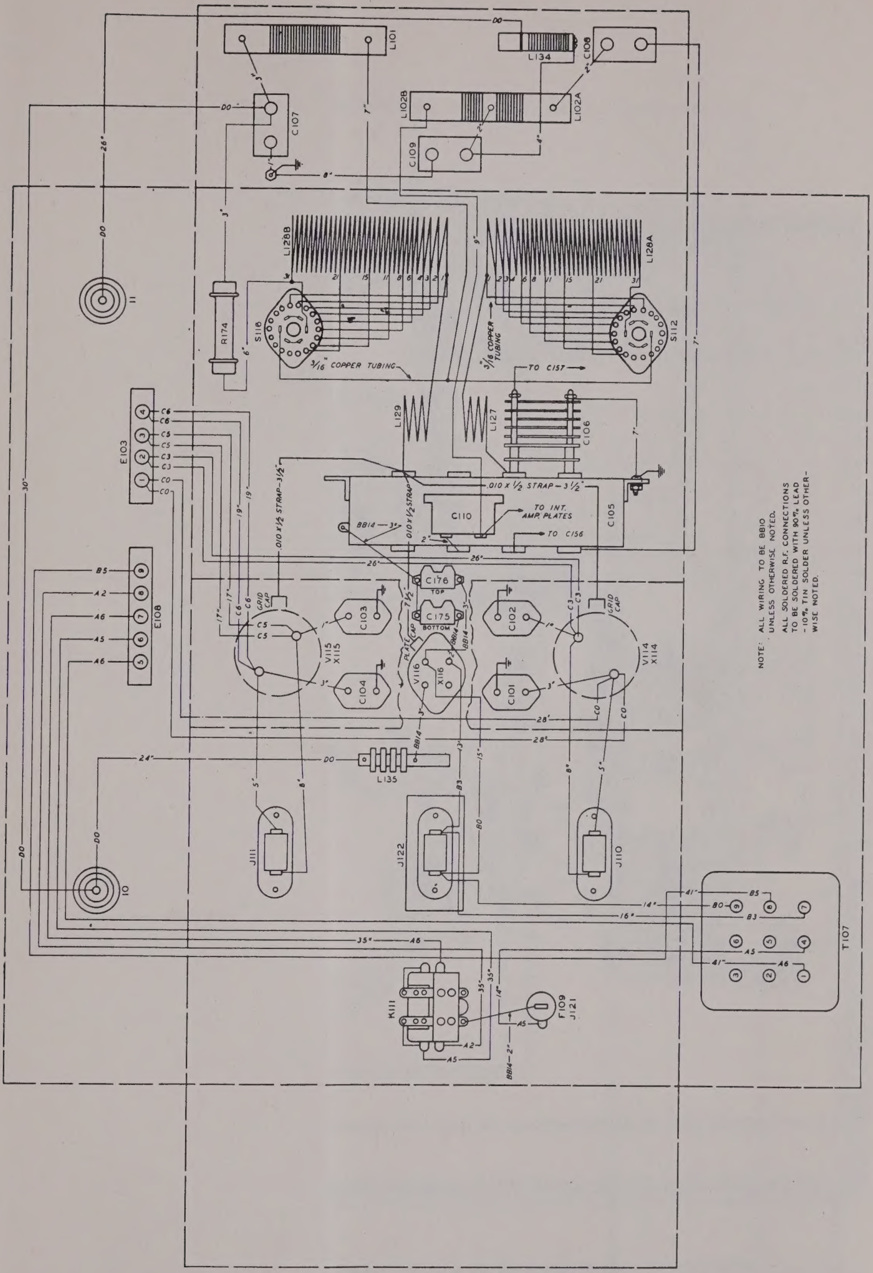


Fig. 94 Power Amplifier Unit Practical Wiring Diagram
(Dwg. No. 500 2827 00D)

ram

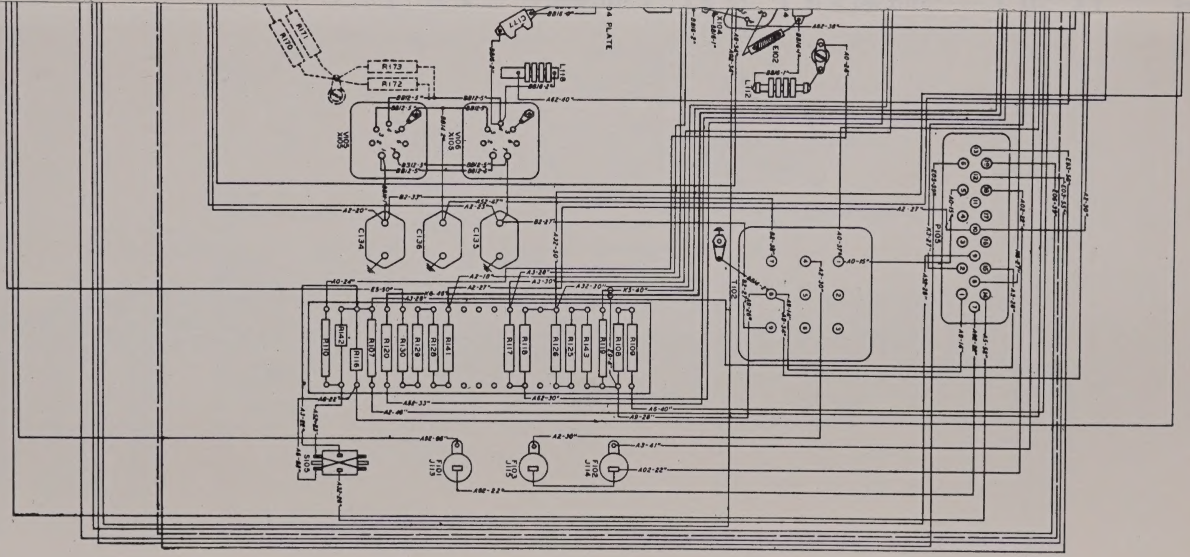


Fig. 95 R-F Exciter Unit Practical Wiring Diagram
(Dwg. No. 500 6626 00E)

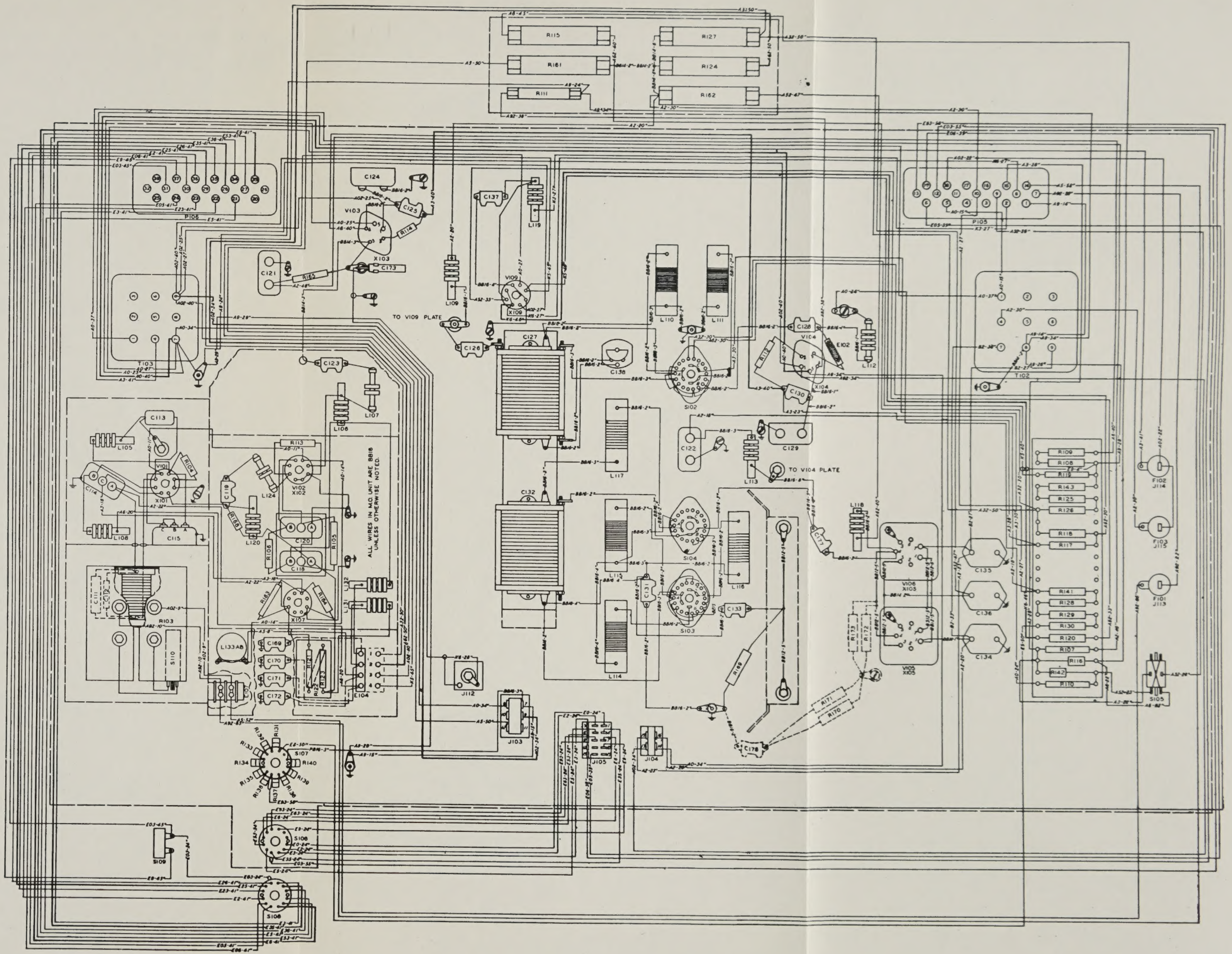


Fig. 95 R-F Exciter Unit Practical Wiring Diagram
(Dwg. No. 500 6626 00E)

Fig. 95 R-F Exciter Unit Practical Wiring Diagram
(Dwg. No. 500 6626 00E)

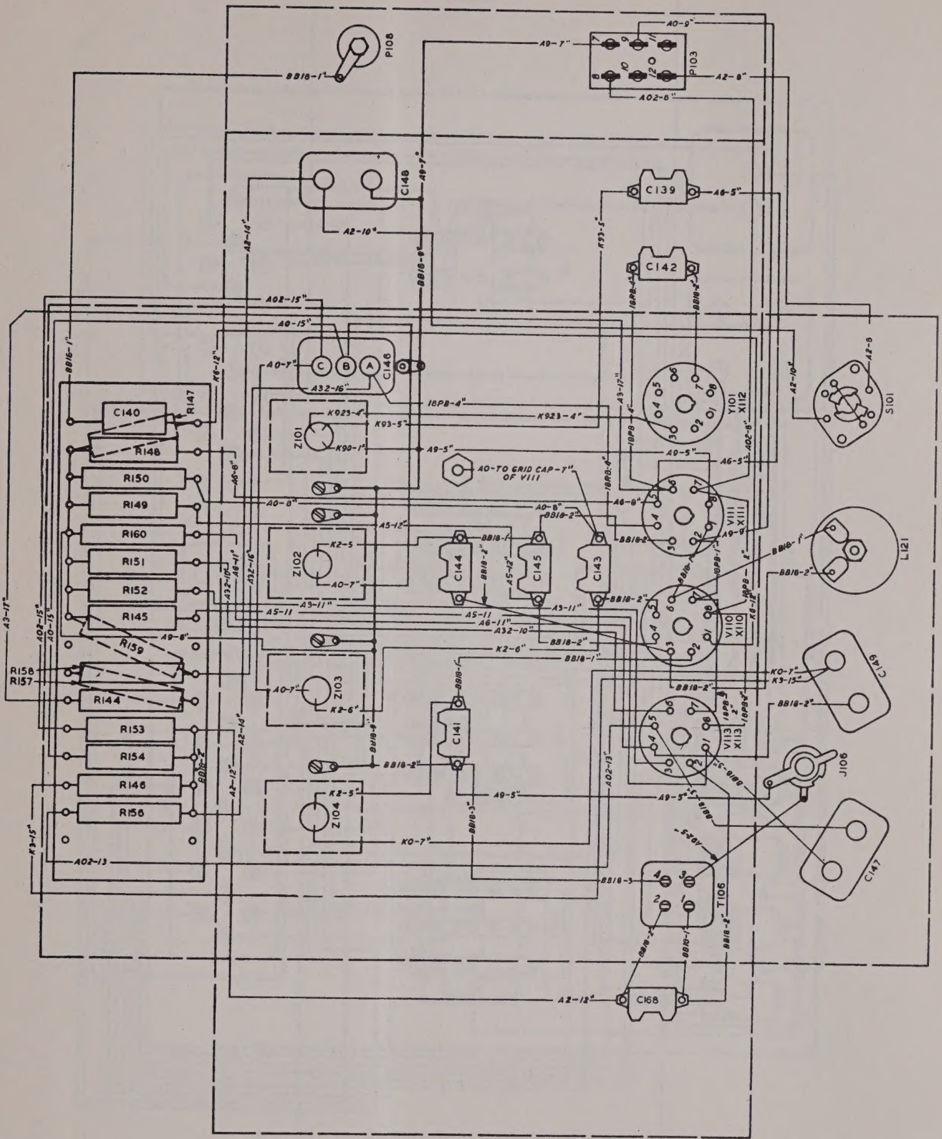


Fig. 96 CFI Unit Practical Wiring Diagram
(Dwg. No. 500 2828 00C)

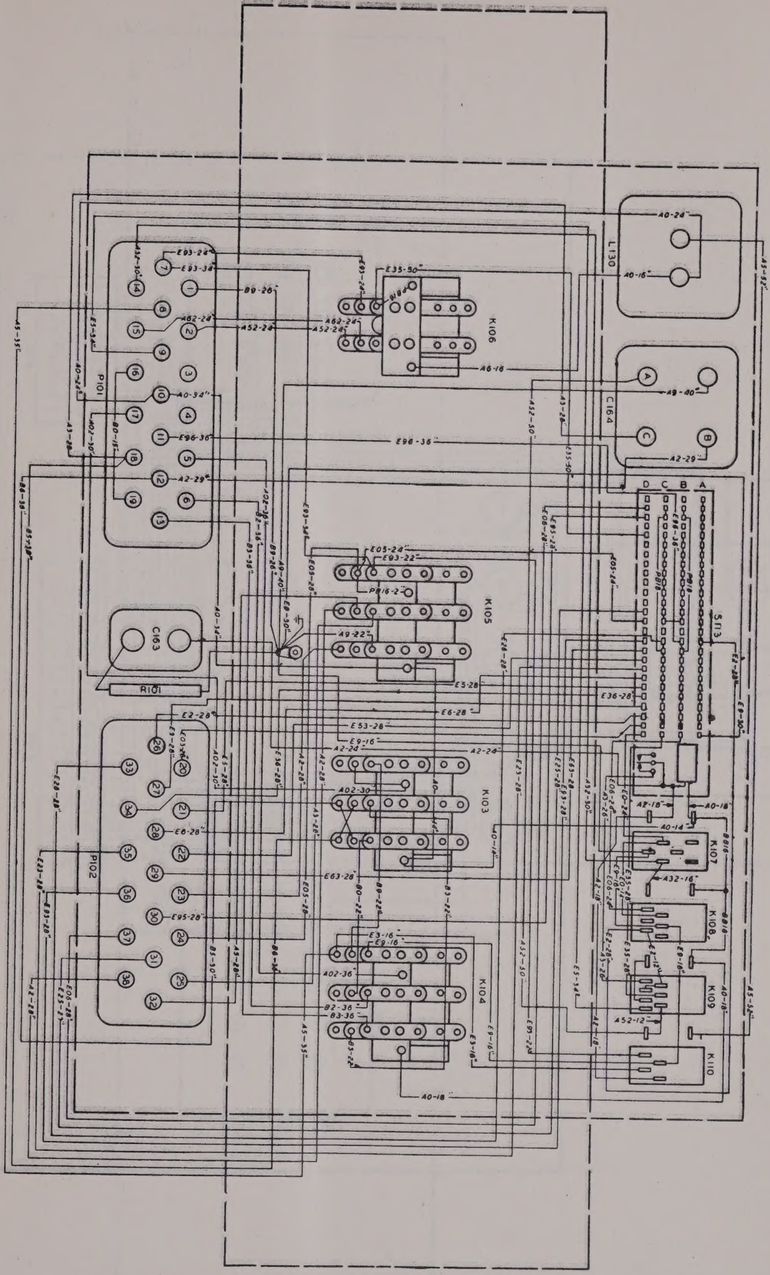


Fig. 97 Autotune Control Unit Practical Wiring Diagram
(Dwg. No. 500 1421 00C)

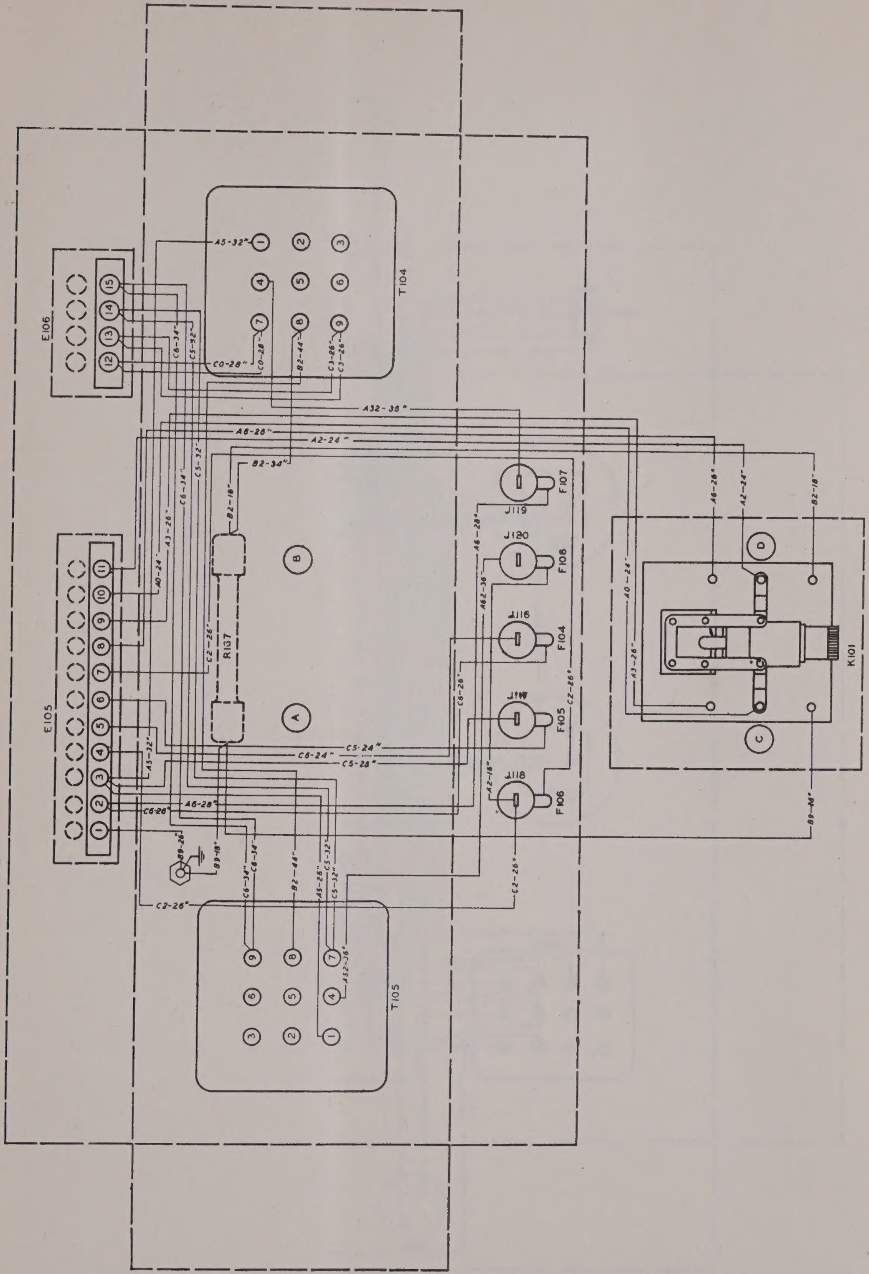


Fig. 98 P.A. Filament Supply Practical Wiring Diagram
(Dwg. No. 500 1537 00C)

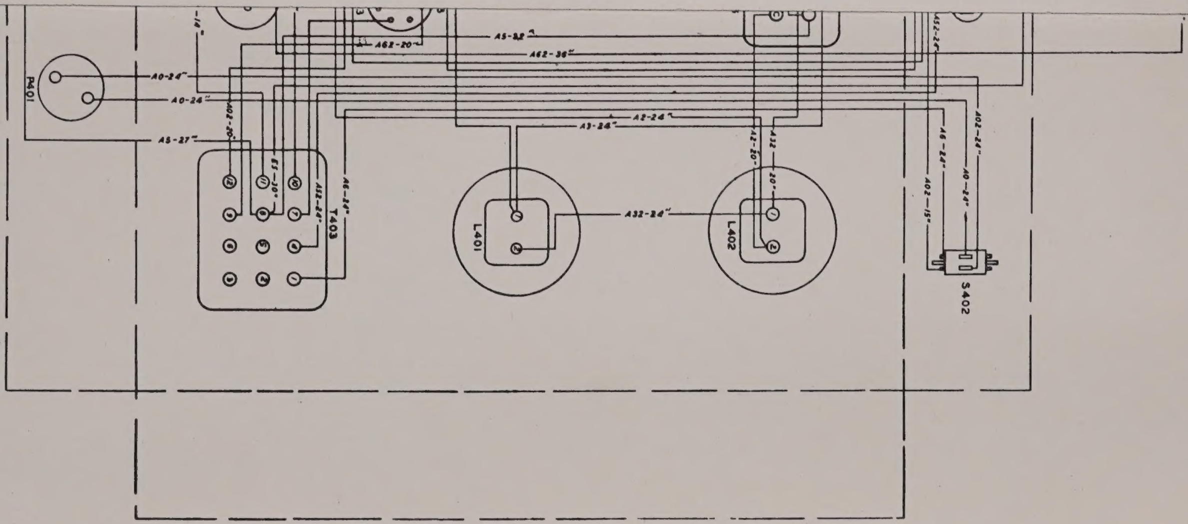


Fig. 99 Remote Control Unit Practical Wiring Diagram
(Dwg. No. 500 1500 00D)

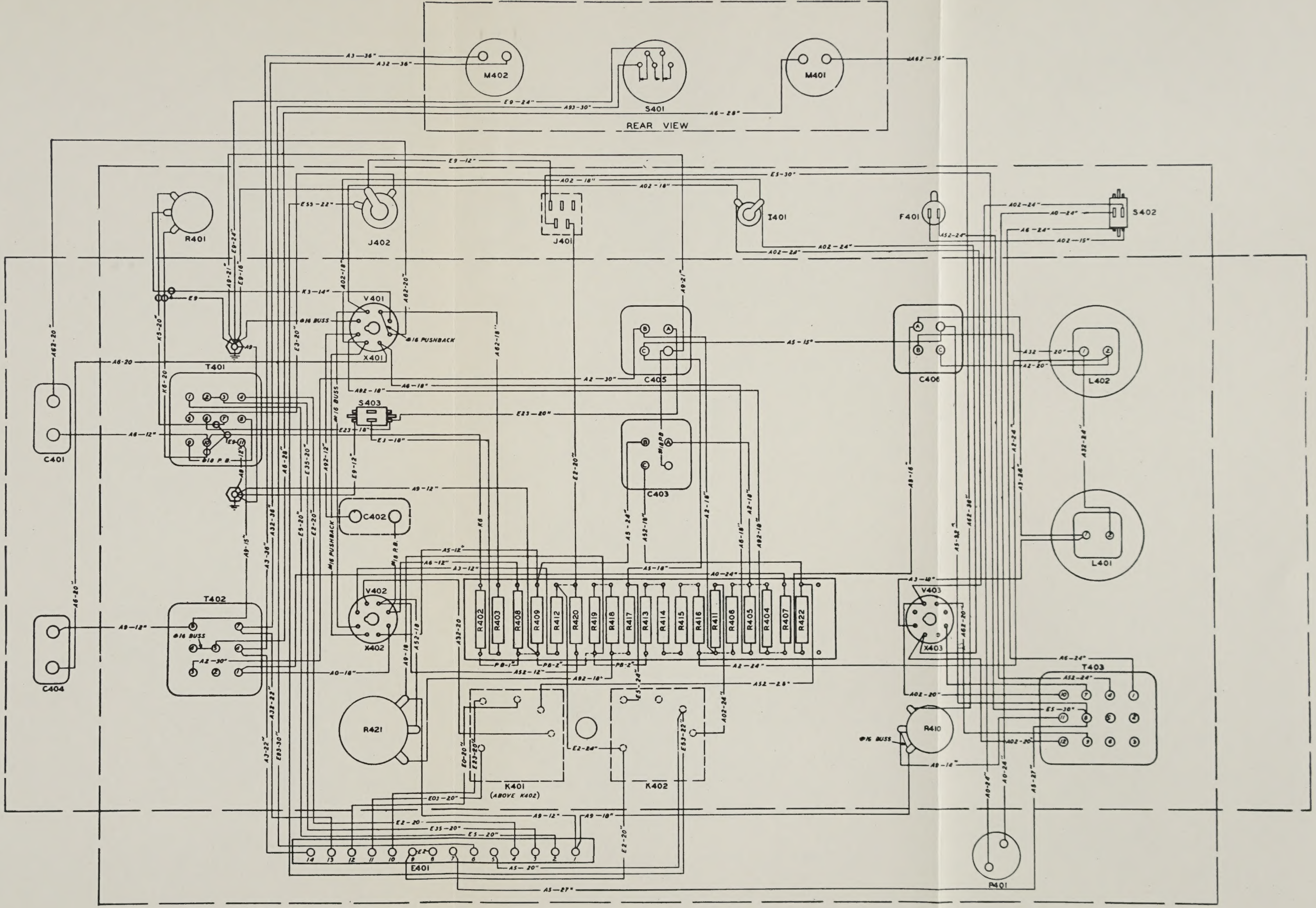
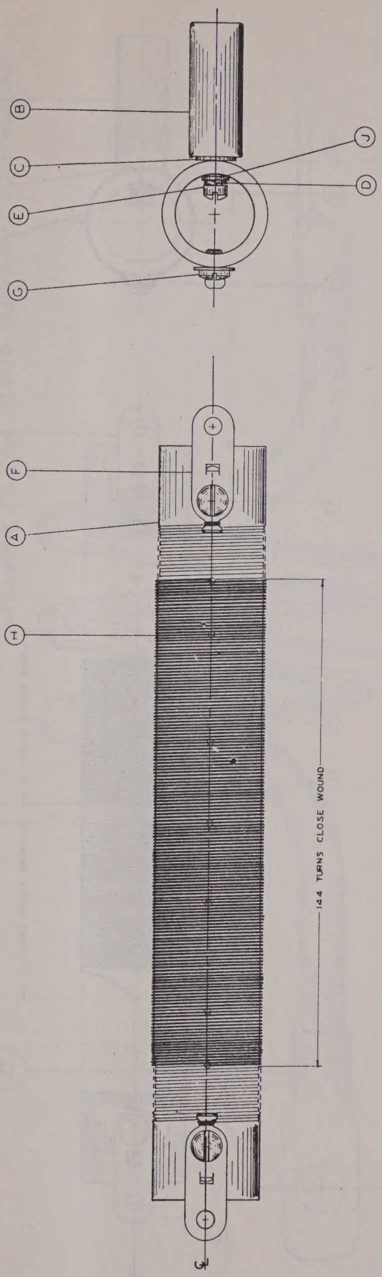


Fig. 99 Remote Control Unit Practical Wiring Diagram
(Dwg. No. 500 1500 00D)

Fig. 99 Remote Control Unit Practical Wiring Diagram
(Dwg. No. 500 1500 00D)

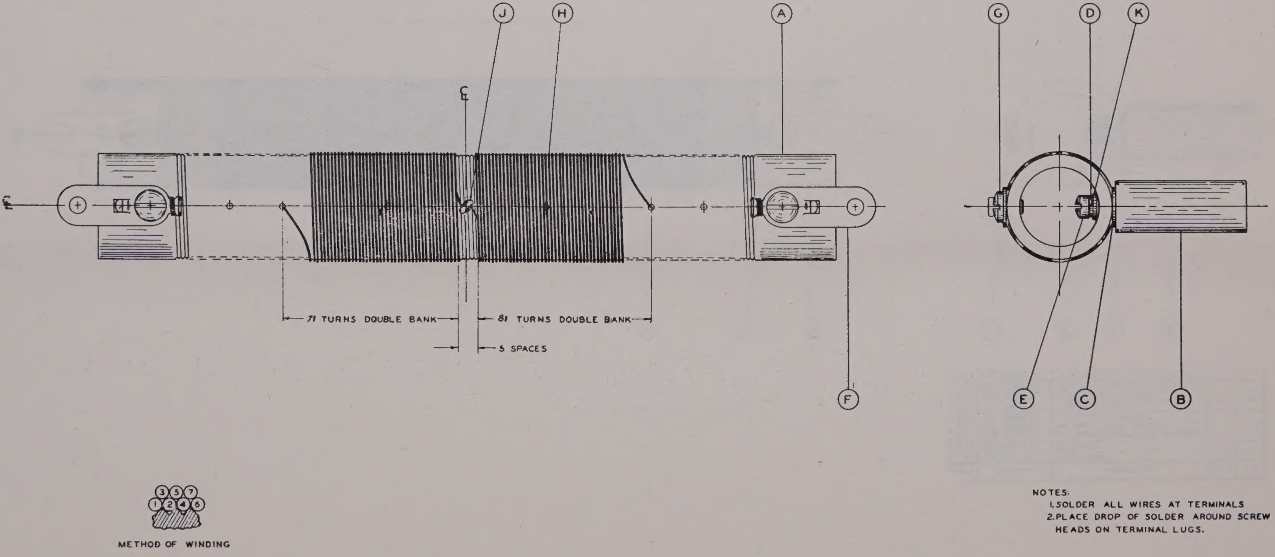
GA	IT.	PART NO.	DESCRIPTION	MAT'L	FIN.
1	A	190 3011 00	COIL FORM		
2	B	190 2323 00	STANDOFF		
2	C	302 5600 00	1/32X3/8 DIA. BAKELITE WASHER		
2	D	310 3526 00	#6 SPLIT LOCK WASHER		
2	E	321 0064 00	6-32X1/2 F.H.SCREW		
2	F	507 7161 00	TERMINAL LUGS		
2	G	323 0050 00	6-32X3/16 B.H. SCREW		
1	H	421 2440 00	#24 DUO ENAM. COP. WIRE 40'		
2	J	302 5700 00	1/32X1/4 DIA. BAKELITE WASHER		



NOTES:
1. SOLDER ALL WIRES AT TERMINALS.
2. PLACE A DROP OF SOLDER AROUND SCREW HEADS ON TERMINAL LUGS.

Fig. 100 Radio-Frequency Choke (L101, L122, L126)
(Dwg. No. 816D)

GA	IT.	PART NO.	DESCRIPTION	MAT'L	FIN.
1	A	190 3011 00	COIL FORM		
2	B	190 2323 00	STANDOFF		
2	C	302 5800 00	1/32X3/8DIA. BAKELITE WASHER		
2	D	310 3528 00	#6 SPLIT LOCK WASHER		
2	E	321 0064 00	6-32X1/2 F.H. SCREW		
2	F	507 7161 00	TERMINAL LUGS		
2	G	323 0050 00	6-32X3/16 B.H. SCREW		
1	H	421 2490 00	#24 D.S.C. COPPER WIRE 45'		
1	J	338 1020 00	COTTER KEY		
2	K	302 5700 00	1/32X1/4 DIA. BAKELITE WASHER		



NOTES:
1. SOLDER ALL WIRES AT TERMINALS
2. PLACE DROP OF SOLDER AROUND SCREW HEADS ON TERMINAL LUGS.

Fig. 101 Int. Amp. Output Coupling Choke (L102)
(Dwg. No. 815D)

GA	ITEM	DESCRIPTION	PART NO.	MAT'L	FIN.
1	A	R.F. COIL	581-1560 30		
2	B	SOLDERING LUG	304 5000 00		

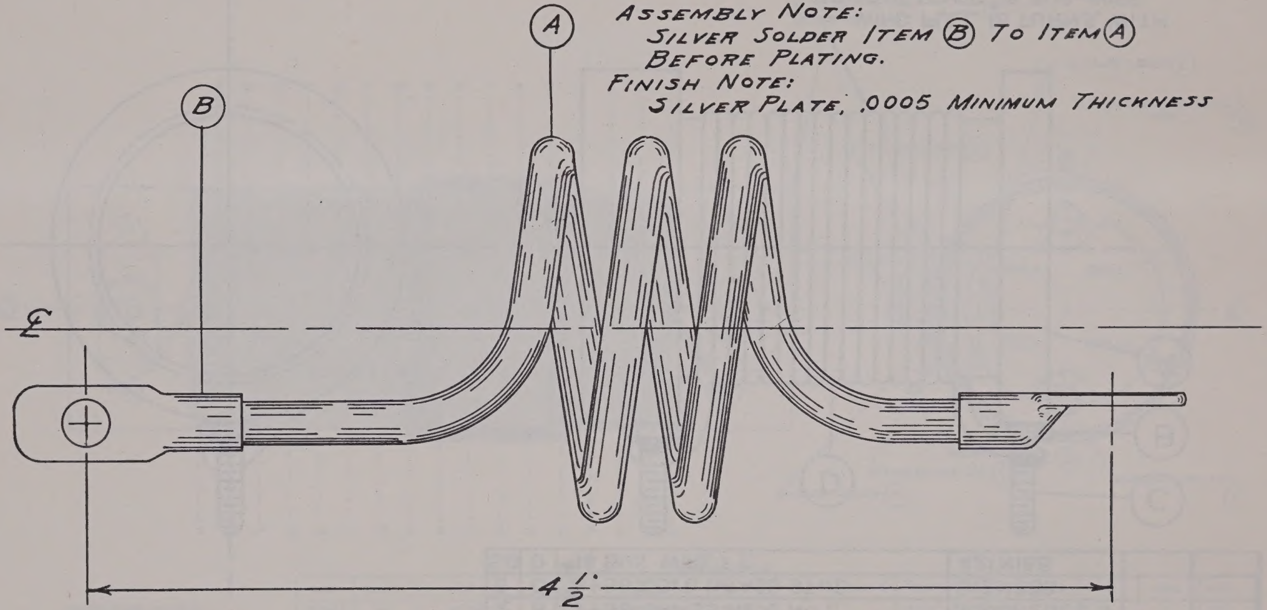
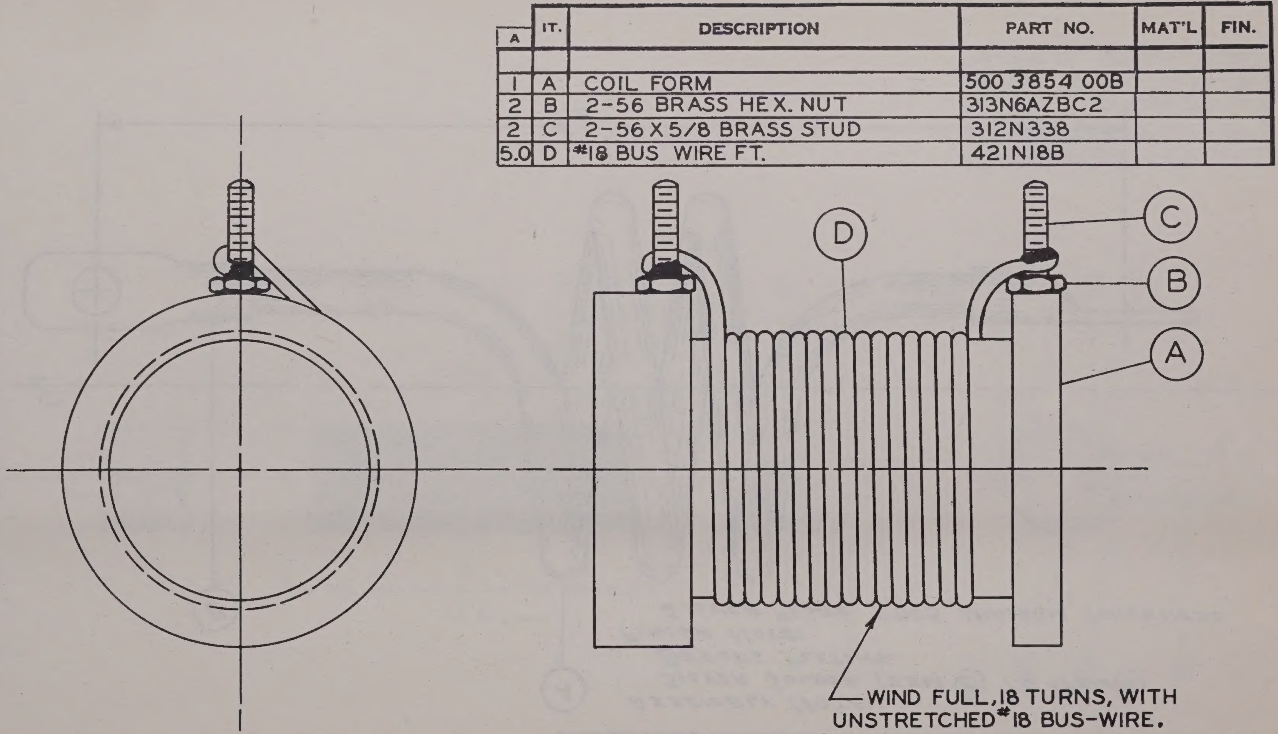

ASSEMBLY NOTE:
SILVER SOLDER ITEM Ⓑ TO ITEM Ⓐ
BEFORE PLATING.
FINISH NOTE:
SILVER PLATE, .0005 MINIMUM THICKNESS

Fig. 102 P.A. Plate Parasitic Suppressor (L103)
(Dwg. No. 1914B)



A	IT.	DESCRIPTION	PART NO.	MAT'L	FIN.
1	A	COIL FORM	500 3854 00B		
2	B	2-56 BRASS HEX. NUT	313N6AZBC2		
2	C	2-56 X 5/8 BRASS STUD	312N338		
5.0	D	#18 BUS WIRE FT.	421N18B		

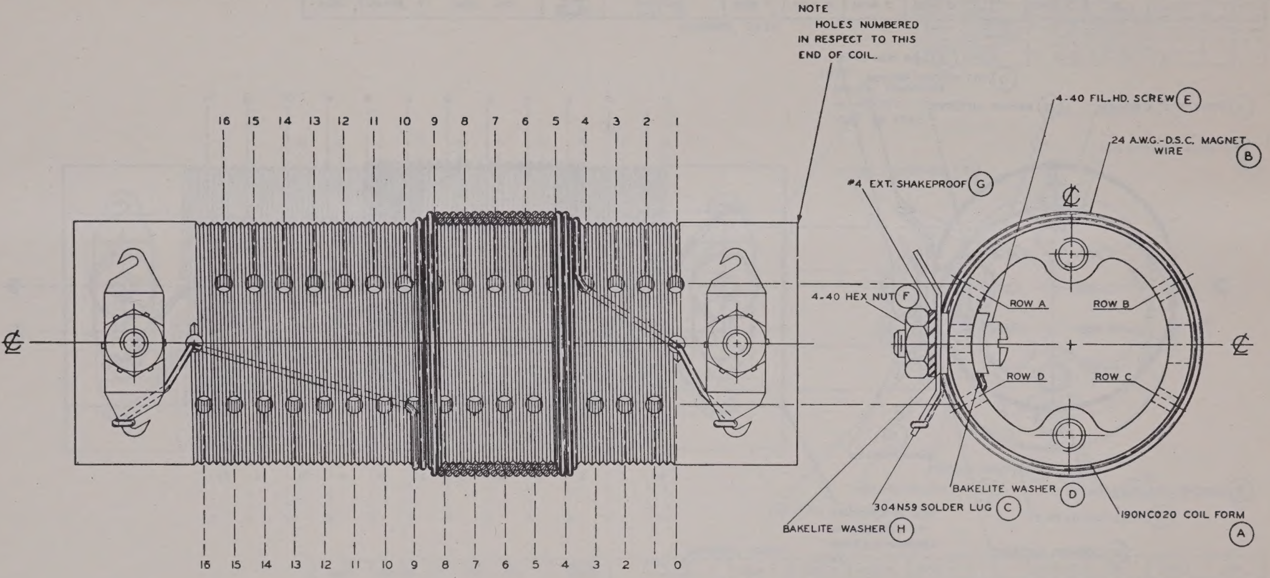
WIND FULL, 18 TURNS, WITH UNSTRETCHED #18 BUS-WIRE.

1-MAINTAIN 10 TO 12 POUNDS TENSION ON THE WIRE WHILE WINDING AND TERMINATING.
2-WRAP ENDS OF WIRE AROUND STUDS, SOLDER, AND REMOVE ALL EXCESS SOLDER AND FLUX.
3-INDUCTANCE MUST BE WITHIN ± 1.0% WHEN CHECKED AGAINST A STANDARD GA-2051A INDUCTANCE. (APPROXIMATE INDUCTANCE 5 MICRO HENRYS).

Fig. 103 M.O. Grid Tuning Inductor (L104)
(Dwg. No. 2051A)

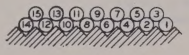
GA	IT.	PART NO.	DESCRIPTION	MAT'L	FIN.
1	A	190NC020	150 COIL FORM		
1	B	421N24R	14 FT. NO. 24 A.W.G. D.S.C. WIRE		
2	C	304N59	SOLDER LUG		
2	D	302N48	BAKELITE WASHER 3/64 T.		
2	E	321N6CXBC	4-40 FILLISTER HEAD		
2	F	313N6CXBC3	4-40 HEX. NUT		
2	G	373N701	#4 EXT. SHAKEPROOF		
2	H	302N38	BAKELITE WASHER 1/32 T.		

RECOMMENDED WIRE SIZE #24 B.&S.
SUBJECT TO WINDING DATA BELOW.



WINDING DATA

WIRE	GAUGE	PART NO.	APPROX. NO. OF TURNS	TYPE OF WINDING	ROW A	ROW B	ROW C	ROW D	L	DIST. C	Q	FREQ.	CAP.
DOUBLE SILK COVERED	24	421N24R	39	DOUBLE BANK	START HOLE #4			STOP HOLE #9	44		95	1.5	328
									44		120	3.0	80.4
14 FT.									μH			M.C.	μμFD

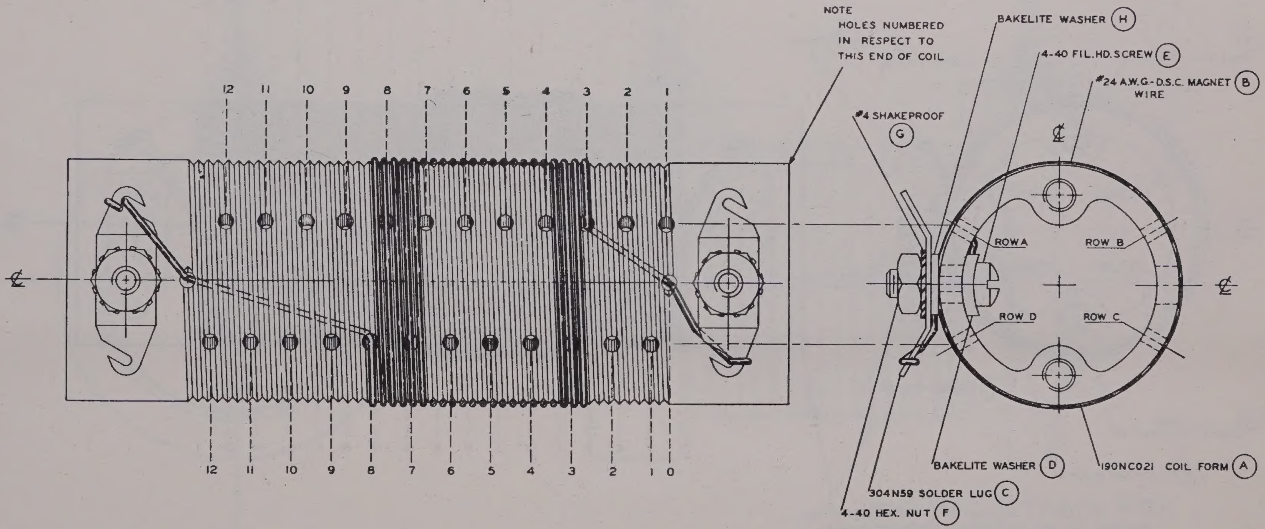


SEQUENCE OF BANK WINDING

Fig. 104 Exciter Plate Tank Inductor (L110, L114)
(Dwg. No. 1435C)

RECOMMENDED WIRE SIZE #24 B.& S.
SUBJECT TO WINDING DATA BELOW.

QA	IT.	PART NO	DESCRIPTION	MAT'L	FIN.
1	A	190 NC021	ISO. COIL FORM		
1	B	421 N24R	6 FT NO. 24 AWG. D.S.C. WIRE		
2	C	304 N59	SOLDER LUG		
2	D	302 N48	BAKELITE WASHER 3/64 T		
2	E	321N6CX8C	4-40 FILLISTER HEAD		
2	F	313 N8 CX8C 3	4-40 HEX NUT		
2	G	373 N 701	# 4 EXT. SHAKEPROOF		
2	H	302 N 38	BAKELITE WASHER 1/32 T.		



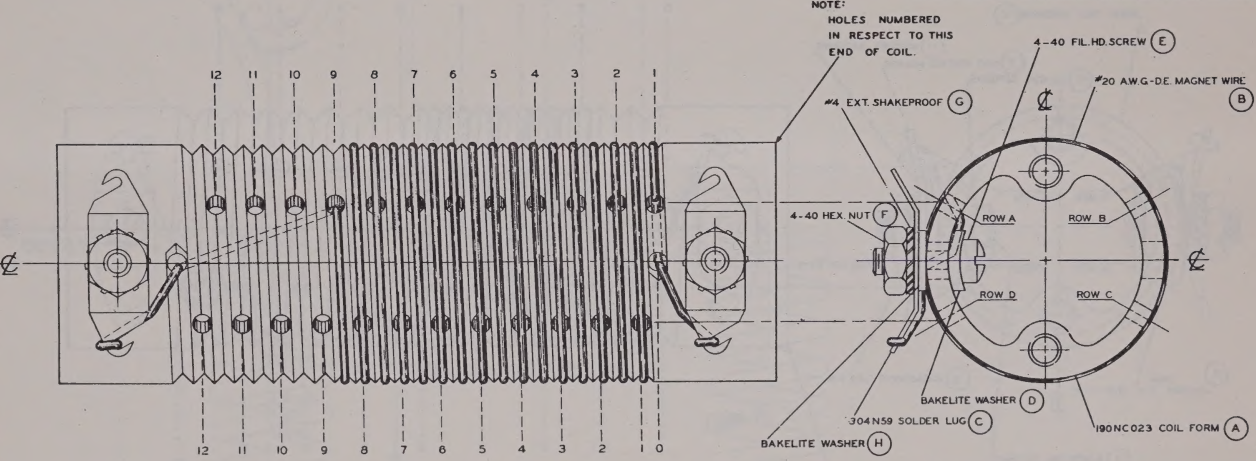
WINDING DATA

WIRE	GAUGE	PART NO.	APPROX. NO. OF TURNS	TYPE OF WINDING	ROW A	ROW B	ROW C	ROW D	L.	DIST. C	Q	FREQ.	CAP.
DOUBLE SILK COVERED 6 FT.	24	421N24R	21	SINGLE LAYER	START HOLE #3			STOP HOLE #8	8.2 8.2 μH		175 240	3.0 6.0 MC	343 86 μμFD

Fig. 105 Exciter Plate Tank Inductor (L111, L115)
(Dwg. No. 1437C)

RECOMMENDED WIRE SIZE #20 B.& S.
SUBJECT TO WINDING DATA BELOW.

QA	IT.	PART NO.	DESCRIPTION	MAT'L	FIN.
1	A	190NC023	ISO. COIL FORM		
1	B	421N20D	5 FT. NO.20 A.W.G., D.E. WIRE		
2	C	304N59	SOLDER LUG		
2	D	302N48	BAKELITE WASHER 3/64 T.		
2	E	321N6CXBC	4-40 FILLISTER HEAD		
2	F	313N6CXBC3	4-40 HEX. NUT		
2	G	373N701	# 4 EXT. SHAKEPROOF		
2	H	302N38	BAKELITE WASHER 1/32 T.		



WINDING DATA

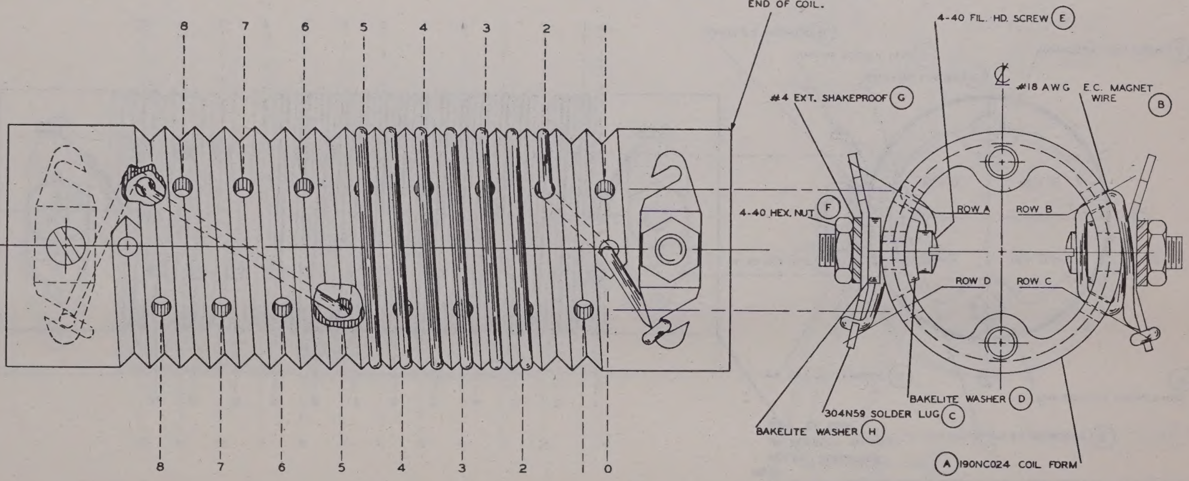
WIRE	GAUGE	PART NO.	APPROX. NO. OF TURNS	TYPE OF WINDING	ROW A	ROW B	ROW C	ROW D	L	DIST. C	Q.	FREQ	CAP.
DOUBLE ENAMELED 5 FT.	20	421N20D	16	SINGLE LAYER	START HOLE #1 STOP HOLE #9				3.6 3 6 μH		200 260	4.5 9.0 MC	350 85 μμFD

Fig. 106 Tripler Plate Tank Inductor (L116)
(Dwg. No. 1438C)

GA	IT.	PART NO.	DESCRIPTION	MAT'L	FIN.
1	A	190NC024	ISO COIL FORM		
1	B	421N18D	2FT. NO. 18 A.W.G E.C. WIRE		
2	C	304N59	SOLDER LUG		
2	D	302N48	BAKELITE WASHER 3/64 T.		
2	E	321N6CX8C	4-40 FILLISTER HEAD		
2	F	313N0CYCC3	4-40 HEX. NUT		
2	G	373N701	#4 EXT. SHAKEPROOF		
2	H	302N38	BAKELITE WASHER 1/32 T.		

RECOMMENDED WIRE SIZE #18 B.& S.
SUBJECT TO WINDING DATA BELOW.

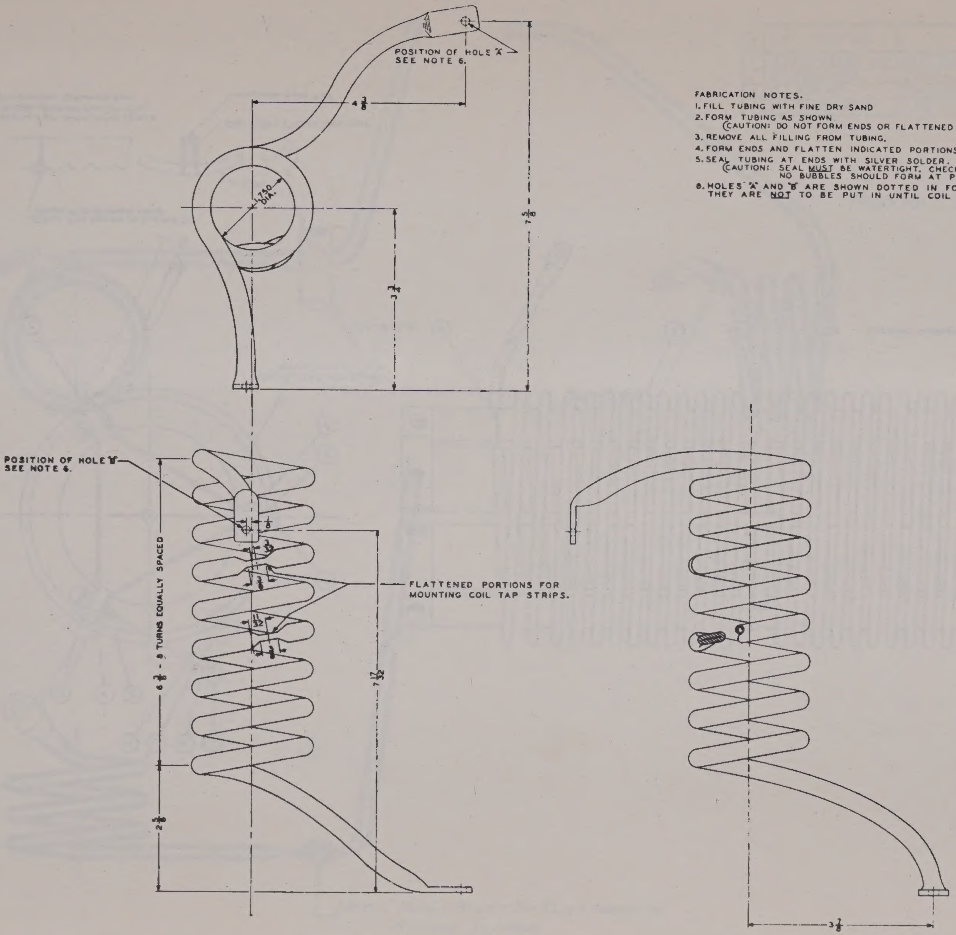
NOTE:
HOLES NUMBERED
IN RESPECT TO THIS
END OF COIL.



WINDING DATA

WIRE	GAUGE	PART NO.	APPROX. NO. OF TURNS	TYPE OF WINDING.	ROW A	ROW B	ROW C	ROW D	L.	DIST. C	Q	FREQ.	CAP.
24 IN.	18	421N18D	6 1/2	SINGLE LAYER	START HOLE#2		STOP HOLE#5		.92 .92 µH		180 245	9.0 18.0 M.C.	340 84 µµF

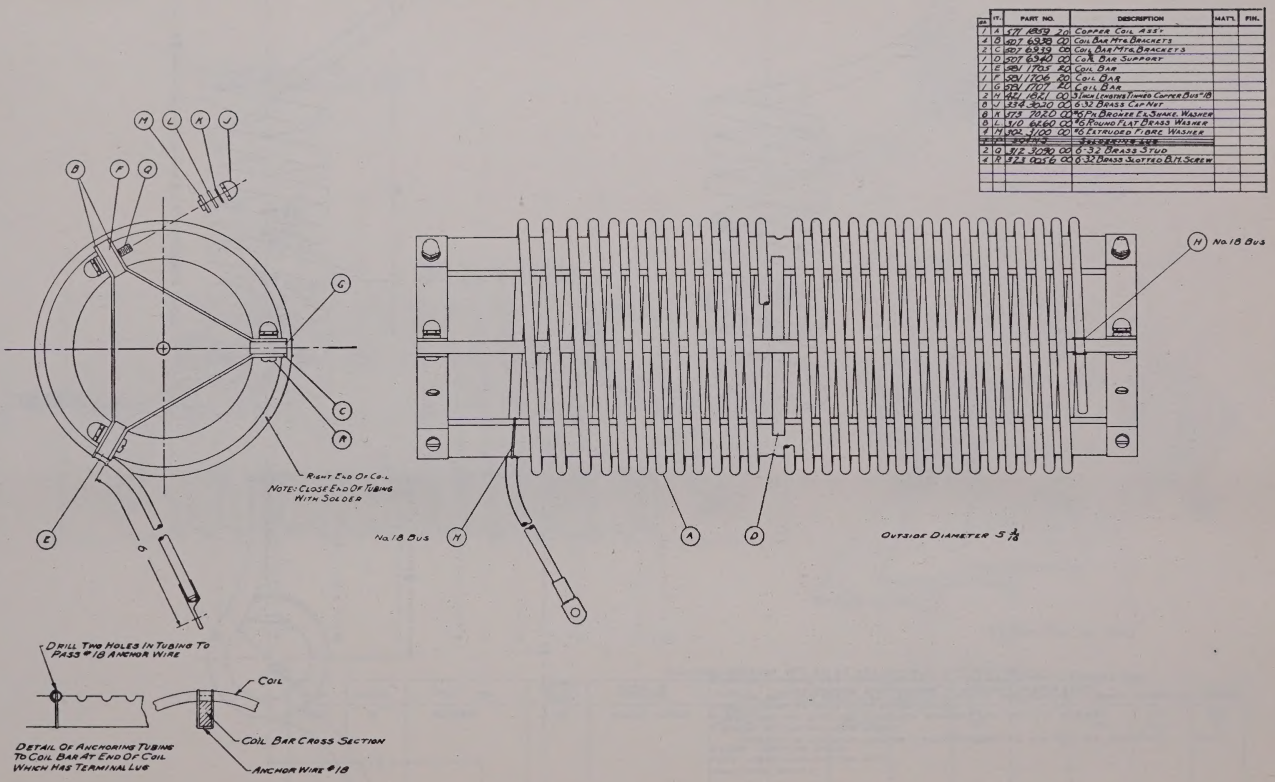
Fig. 107 Tripler Plate Tank Inductor (L117)
(Dwg. No. 1436C)



FABRICATION NOTES.

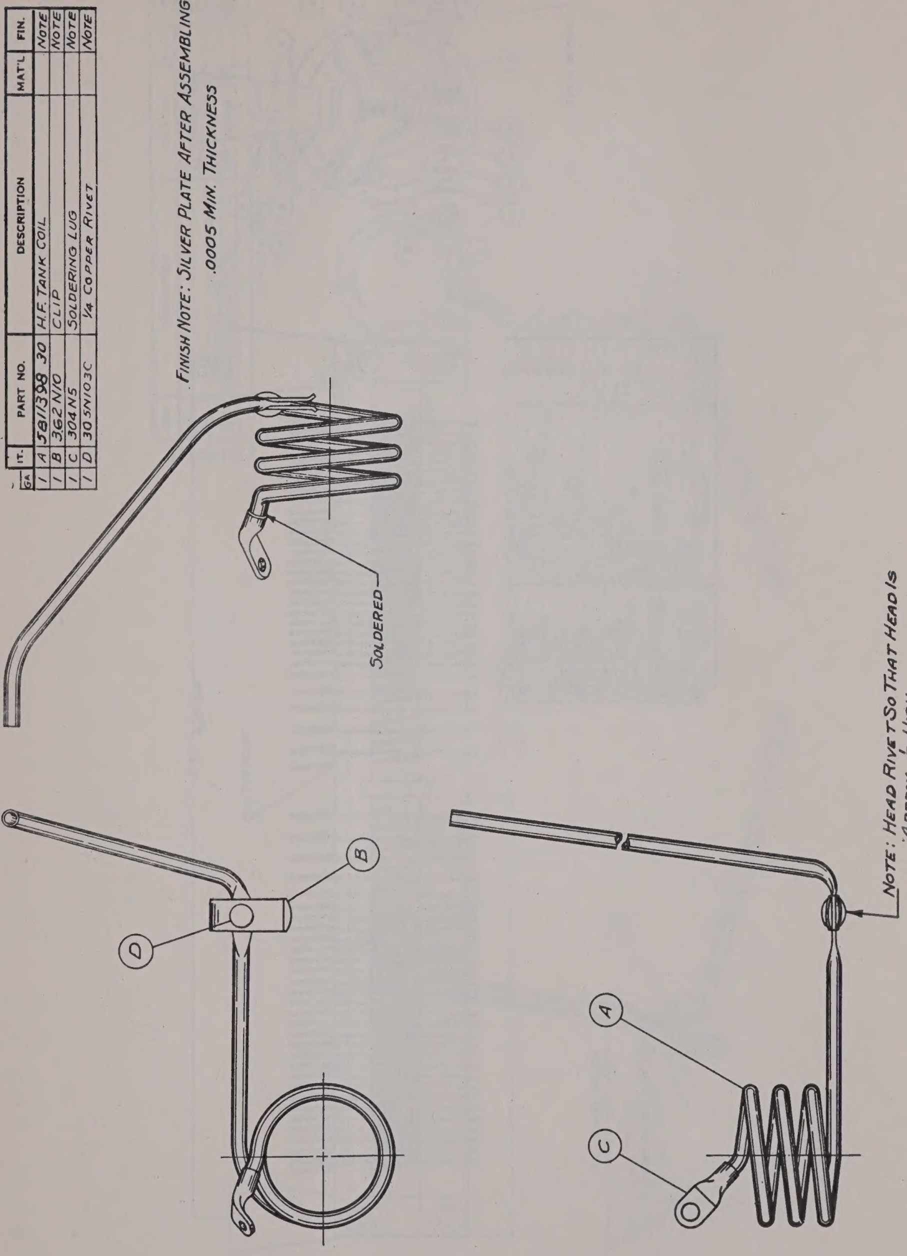
1. FILL TUBING WITH FINE DRY SAND
2. FORM TUBING AS SHOWN.
   (CAUTION: DO NOT FORM ENDS OR FLATTENED PORTIONS FOR COIL TAP STRIP.)
3. REMOVE ALL FILLING FROM TUBING.
4. FORM ENDS AND FLATTEN INDICATED PORTIONS FOR COIL TAP STRIPS.
5. SEAL TUBING AT ENDS WITH SILVER SOLDER.
   (CAUTION: SEAL MUST BE WATERTIGHT. CHECK BY IMMERSING COLD TUBING IN BOILING WATER NO BUBBLES SHOULD FORM AT PROPERLY SEALED ENDS.)
6. HOLES 'A' AND 'B' ARE SHOWN DOTTED IN FOR REFERENCE PURPOSES ONLY. THEY ARE NOT TO BE PUT IN UNTIL COIL ASSEMBLY.

Fig. 108 P.A. Plate Tank Inductor (L123)
(Dwg. No. 500 2944 00D)


H
No.18 Bus
Outside Diameter 5 3/16
D
A
H
No.18 Bus
G
C
R
Right End Of Coil
Note: Close End Of Tubing With Solder
J
K
L
M
B
F
Q
E
6
Drill Two Holes In Tubing To Pass #18 Anchor Wire
Coil
Coil Bar Cross Section
Anchor Wire #18
Detail Of Anchoring Tubing To Coil Bar At End Of Coil Which Has Terminal Lug

QA	IT.	PART NO.	DESCRIPTION	MAT'L	FIN.
1	A	571 1859 20	Copper Coil Ass'y		
4	B	507 6938 00	Coil Bar Mtg. Brackets		
2	C	507 6939 00	Coil Bar Mtg. Brackets		
1	D	507 6940 00	Coil Bar Support		
1	E	581 1705 20	Coil Bar		
1	F	581 1706 20	Coil Bar		
1	G	581 1707 20	Coil Bar		
2	H	421 1821 00	3 Inch Lengths Tinned Copper Bus #18		
8	J	334 3020 00	6-32 Brass Cap Nut		
8	K	373 7020 00	#6 Ph. Bronze Ex. Shake. Washer		
8	L	310 6260 00	#6 Round Flat Brass Washer		
4	M	302 3100 00	#6 Extruded Fibre Washer		
~~1~~	~~P~~	[illegible]	[illegible]		
2	Q	312 3090 00	6-32 Brass Stud		
4	R	323 0056 00	6-32 Brass Slotted B.H. Screw		

Fig. 109 P.A. Plate Tank Inductor (L125)
(Dwg. No. 701D)

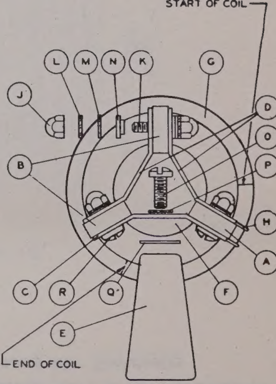


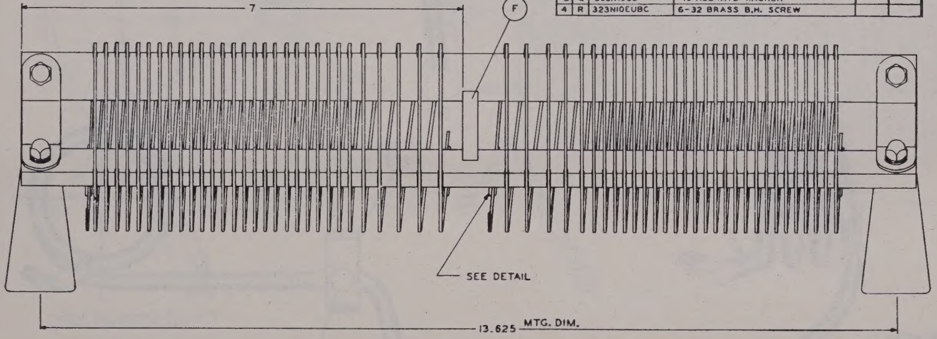
GA	IT.	PART NO.	DESCRIPTION	MAT'L	FIN.
1	A	5811398 30	H.F. TANK COIL		NOTE
1	B	362N10	CLIP		NOTE
1	C	304N5	SOLDERING LUG		NOTE
1	D	305N103C	1/4 COPPER RIVET		NOTE

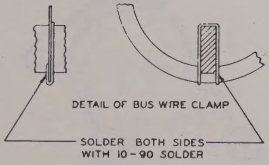
FINISH NOTE: SILVER PLATE AFTER ASSEMBLING .0005 MIN. THICKNESS

NOTE: HEAD RIVET SO THAT HEAD IS APPROX 1/16 HIGH.

Fig. 110 H-F P.A. Plate Tank Inductor (L127)
(Dwg. No. 1401C)







GA	IT.	PART NO	DESCRIPTION	MAT'L	FIN.
1	A	571 1169 30	COIL BAR		
2	B	572 1169 30	COIL BAR		
2	C	507,7000 00	COIL BAR SUPPORT BRACKET		
4	D	507 6999 00	COIL BAR SUPPORT BRACKET		
2	E	190NSN2	STANDOFF		
1	F	507 7001 00	COIL BAR SEPARATOR		
2	G	YA-1894B	R. H. RIBBON COIL		
4	H	421N18B	3" #16 BUS WIRE		
8	J	334N302	6-32 CAP NUT		
2	K	312N302	6-32 X 1" STUD		
8	L	373N702	#6 EXT. PH. B. SHAKEPROOF		
8	M	310NFB6	#6 FLAT BRASS WASHER		
4	N	302N31	FIBER WASHER		
2	O	323N8GUBC	10-32 X 1/2 SL. BINDER HEAD SCREW		
2	P	373N704	10 EXT. PH. B. SHAKEPROOF		
2	Q	303N103C	10 ACETATE WASHER		
4	R	323N10EUBC	6-32 BRASS B.H. SCREW		

Fig. 111 P.A. Grid Inductor (L128)
(Dwg. No. 1413C)

GA	ITEM	DESCRIPTION	PART NO.	MAT'L	FIN.
1	A	COIL	581-1724 20		NOTE
1	B	CLIP	362 1000 00		NOTE
1	C	SOLDERING LUG	304 5000 00		NOTE
1	D	1/4 COPPER RIVET	305 1033 00		NOTE

FINISH NOTE: SILVER PLATE
AFTER ASSEMBLY
.0005 MIN. THICKNESS

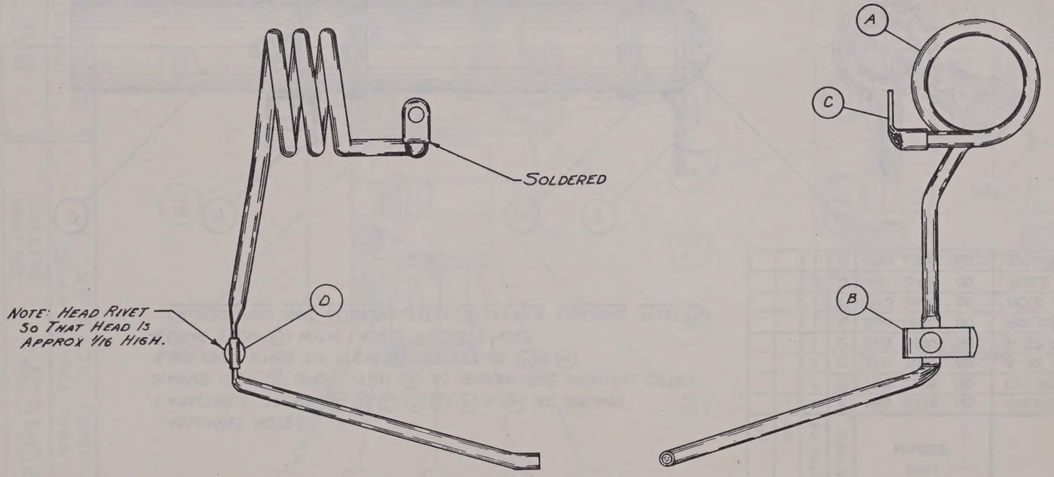
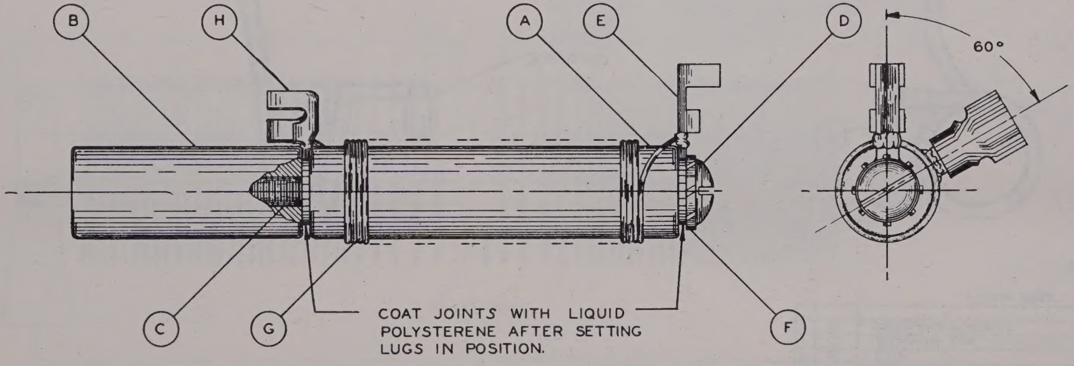


Fig. 112 P.A. Grid Inductor (L129)
(Dwg. No. 1730B)

QUANTITIES LISTED ARE FOR ONE ASSEMBLY					
500	500	500 2071 00B	ITEM NO.	PART NUMBER	PART NAME
		1	A	190 2326 00	CYLINDRICAL STANDOFF
		1	B	190 2328 00	CYLINDRICAL STANDOFF
		1	C	312 3060 00	8-32 X 7/8 STUD
		1	D	323 0072 00	8-32 X 1/2 B.H.SCREW
		1	E	304 1900 00	SOLDER LUG
		1	F	373 7030 00	NO.8 EXT.SHAKEPR. WSHR.
		9	G	421 2490 00	SGLE. COND.MGNT. WIRE D.S.C.(FT
		1	H	304 1300 00	SOLDER LUG

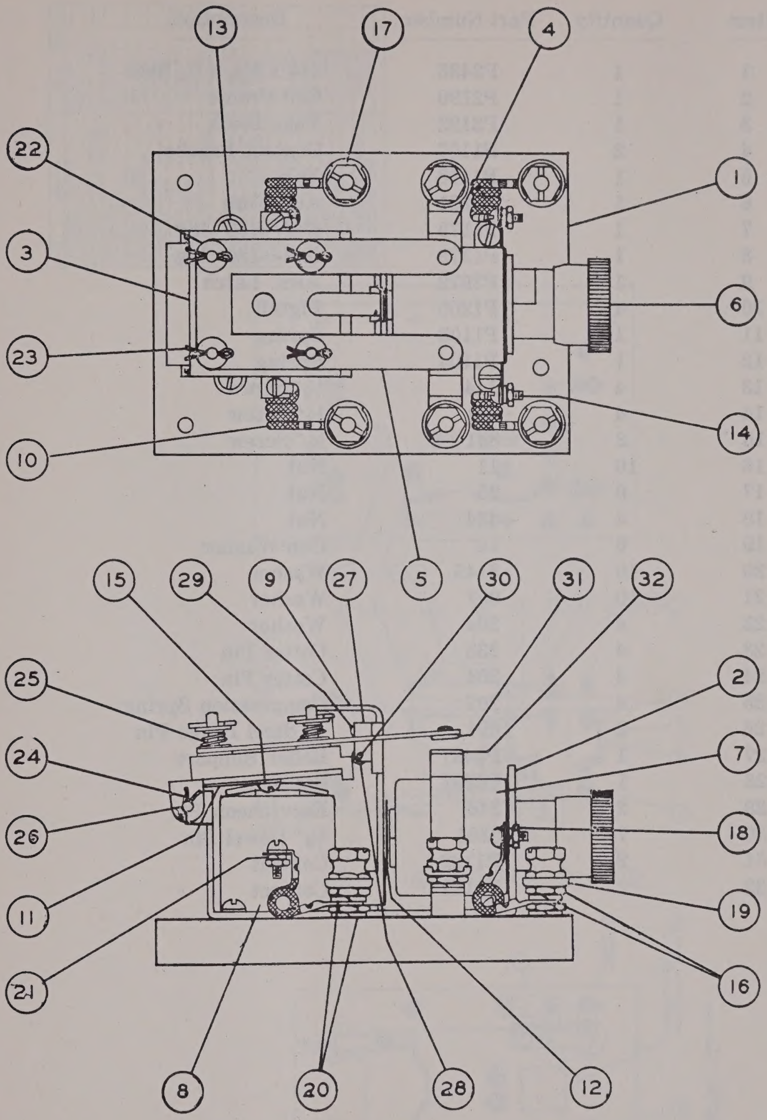
ASSEMBLY NOTES.

1 ASSEMBLE ITEMS Ⓐ,Ⓑ,Ⓒ,Ⓓ,Ⓔ,Ⓕ & Ⓗ AS SHOWN
2.WIND ITEM Ⓖ UPON ITEM Ⓐ AS SHOWN (SEE WINDING DATA)
3.SOLDER ENDS OF ITEM Ⓖ TO ITEMS Ⓔ & Ⓗ
4.COAT ITEM Ⓖ WITH LIQUID POLYSTERENE.
CAUTION: DO NOT LOOSEN ITEM Ⓑ AFTER COATING ITEM Ⓖ


B
H
A
E
D
60°
C
G
COAT JOINTS WITH LIQUID POLYSTERENE AFTER SETTING LUGS IN POSITION.
F

WINDING DATA:
SINGLE LAYER, 68 TURNS, CLOSE WOUND,
CENTERED ON COIL FORM (190NSL2)

Fig. 113 Int. Amp. Plate Choke (L134)
(Dwg. No. 500 2071 00B)



STRUTHERS DUNN INCORPORATED PHILADELPHIA, PENNSYLVANIA		COLLINS RADIO COMPANY CEDAR RAPIDS, IOWA	
STRUTHERS DUNN PART NUMBER:	CX3390	COLLINS PART NO:	405NC4

Fig. 114 Relay Assembly (K101)
(Dwg. No. 1272B)

Item	Quantity	Part Number	Description
1	1	P3433	4½ x 3¼ x ½ Base
2	1	P2190	Coil Frame
3	1	P3122	Yoke Block
4	2	P1107	Contact Bracket
5	1	P1118	Yoke
6	1	P2291	Adj. Core
7	1	P1179	Coil—180° lug
8	1	P1179	Coil—180° lug
9	1	P3572	Arm. Latch
10	4	P1205	Pigtail
11	1	P1103	Spring
12	1	P1104	Spring
13	4	144	½″ Screw
14	4	841	¼″ Screw
15	2	841	¼″ Screw
16	10	11	Nut
17	6	35	Nut
18	4	434	Nut
19	6	14	Cup Washer
20	10	3145	Washer
21	10	997	Washer
22	4	264	Washer
23	4	233	Cotter Pin
24	4	204	Cotter Pin
25	4	202	Compression Spring
26	2	491	S. Steel Hinge Pin
27	1	P3437	Roller Support
28	1	P3437	Roller
29	2	246	Escutcheon Pin
30	1	3301	⅜″ Dowel Pin
31	2	P1122	Contact
32	2	P1121	Contact

A	IT	DESCRIPTION	PART NO.	MAT'L	FIN.
1	X	ASSEMBLY PER QUANTITY "A"	571 0514 40		
1	A	CONNECTOR LINK	500 1584 00A		
2	B	CONTACT MOUNTING INSULATOR	500 4087 00A		
2	C	CONTACT MOUNTING INSULATOR	500 4086 00A		
1	D	BASE PLATE	571 1527 20		
1	E	RELAY ARM PLATE	5076473 00		
1	F	ARM PLATE COVER	5076472 00		
1	G	RELAY COUNTERWEIGHT	5076471 00		
5	H	SOLDERING LUG	3041800 00		
39	J	#6 FLAT BRASS WASHER	310 6260 00		
9	K	6-32 × 1¼ STUD	312 3430 00		
43	L	6-32 BRASS NUT	313 0001 00		
4	M	10-32 BRASS NUT	3130007 00		
2	N	6-32 × ½ FLAT HEAD SCREW	322 0038 00		
4	P	4-36 × [illegible] PH B H SCREW	343 0147 00		
2	Q	6-32 × ⅜ PH B H SCREW	3430168 00		
6	R	6-32 × 7/16 PH B H SCREW	343 0170 00		
8	S	6-32 × ¾ PH B H SCREW	3430174 00		
4	T	TERMINAL	367 500000		
4	U	#4 SHAKEPROOF WASHER	373 7010 00		
51	V	#6 SHAKEPROOF WASHER	373 702000		
2	W	CONTACT ASSEMBLY	404 170000		
4	Y	CONTACT	404 160000		
2	Z	CONTACT ASSEMBLY	404 380000		
1	AA	RELAY MOTOR	405 710000		
8"	AB	WIRE	423 100000		
1	AC	510 OHM 2 WATT RESISTOR	729 8510 40		
1	AD	25 MFD. CONDENSER	956 205840		

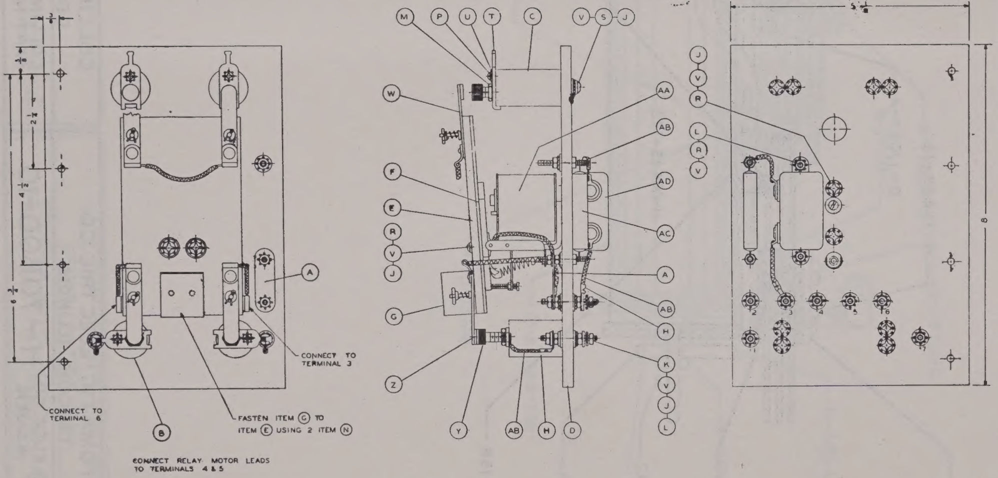
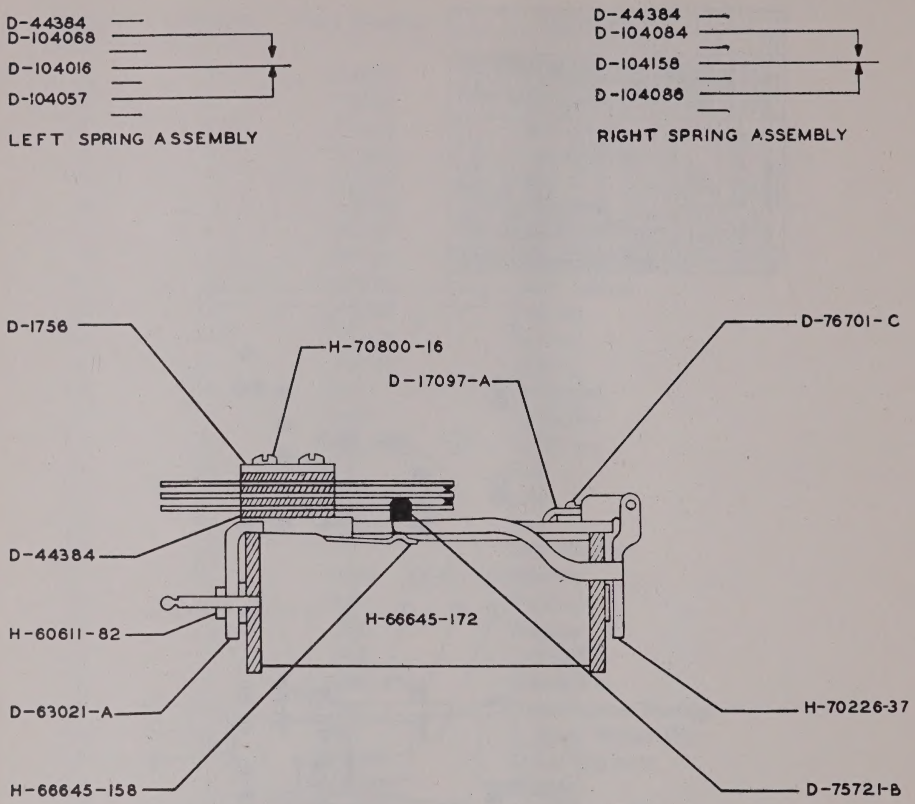
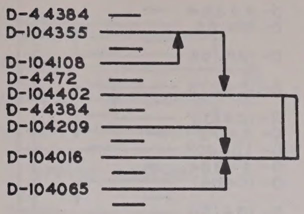


Fig. 115 Relay Assembly (K102)
(Dwg. No. 514D)

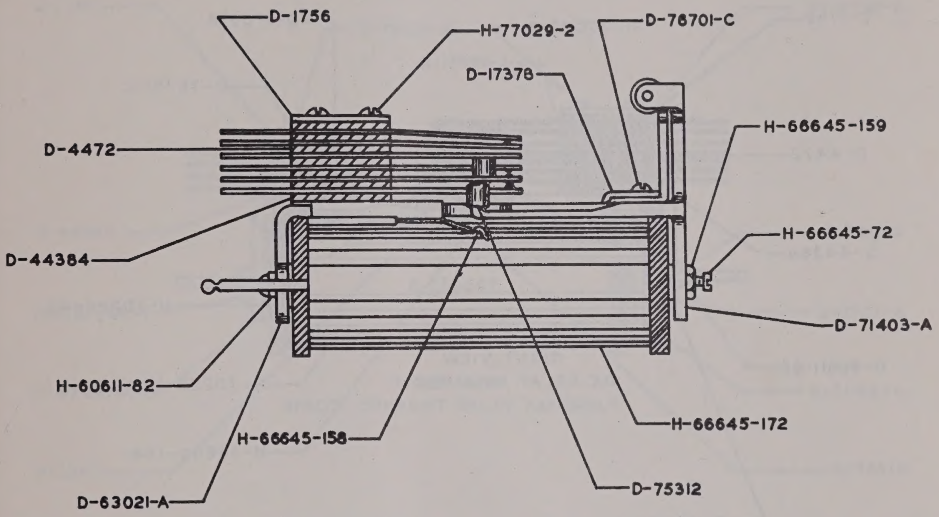


AUTOMATIC ELECTRIC CO. CHICAGO ILLINOIS	COLLINS RADIO COMPANY CEDAR RAPIDS IOWA
AUTO. ELEC. CO. PART NUMBER: H-70800-10	COLLINS PART NO. 972N13

Fig. 116 Relay Assembly (K107)
(Dwg. No. 1723B)

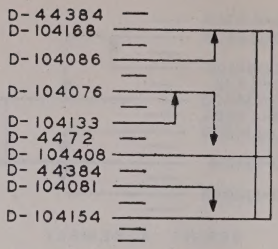


SPRING ASSEMBLY

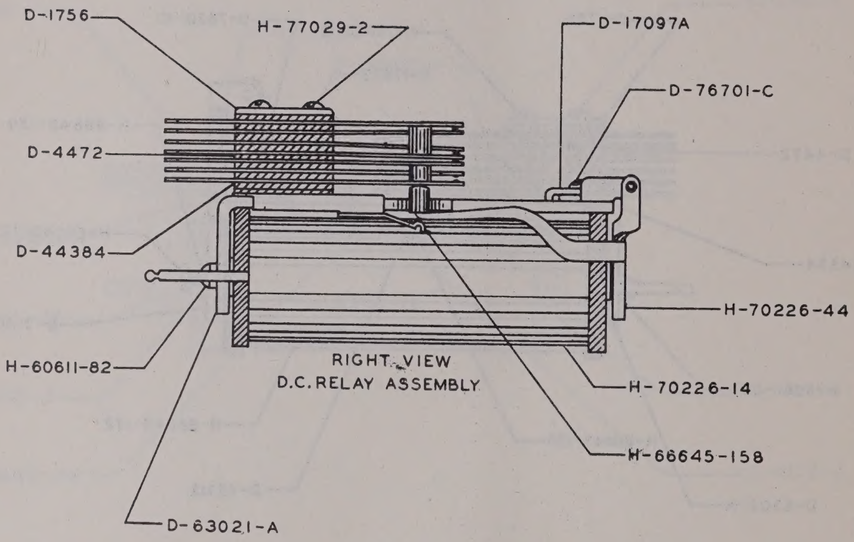


AUTOMATIC ELECTRIC CO CHICAGO, ILLINOIS	COLLINS RADIO COMPANY CEDAR RAPIDS, IOWA
AUTO ELEC CO. PART NUMBER: H-77029-4	COLLINS PART NO: 972 1600 00

Fig. 117 Relay Assembly (K108)
(Dwg. No. 500 1504 00B)



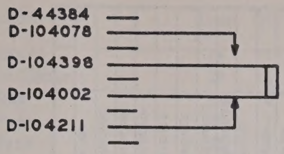
SPRING ASSEMBLY



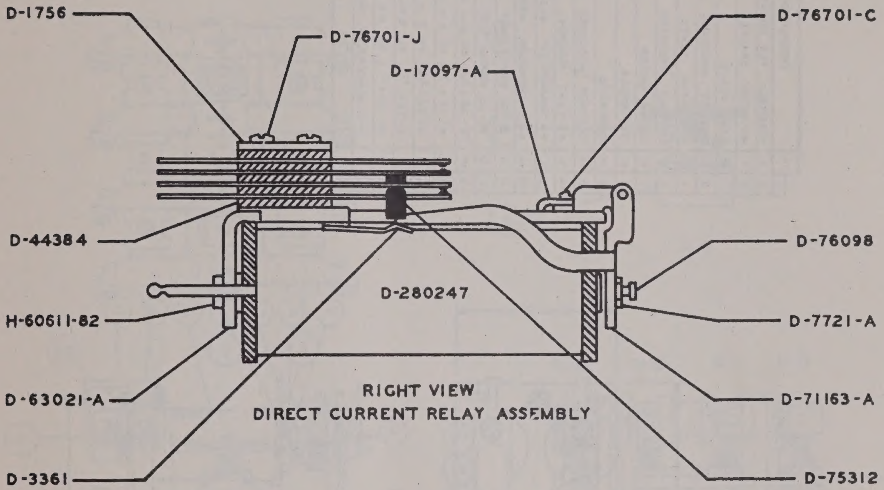
RIGHT VIEW
D.C. RELAY ASSEMBLY

AUTOMATIC ELECTRIC CO. CHICAGO, ILLINOIS		COLLINS RADIO COMPANY CEDAR RAPIDS, IOWA	
AUTO ELEC.CO. PART NUMBER:	H-77029-1	COLLINS PART NO:	972N15

Fig. 118 Relay Assembly (K109)
(Dwg. No. 1913B)



SPRING ASSEMBLY



RIGHT VIEW
DIRECT CURRENT RELAY ASSEMBLY

AUTOMATIC ELECTRIC CO. CHICAGO ILLINOIS	COLLINS RADIO COMPANY CEDAR RAPIDS IOWA
AUTO. ELEC. CO. PART NUMBER: H-70226-1	COLLINS PART NO: 972N1

Fig. 119 Relay Assembly (K110)
(Dwg. No. 963B)

A	IT.	DESCRIPTION	PART NO.	MAT'L	FIN.
1	X	ASSEMBLY PER QUANTITY "A"	571 1524 '20	---	U
2	A	MOUNTING BRACKET	X-6453	S1	F1
1	B	BASE PLATE	X-6454	P3	W1
3	C	CONTACT MOUNTING INSULATOR	X-6455-1½	P3	W1
1	D	INSULATOR PLATE	X-6457	P3	W1
1	E	CONTACT MOUNTING PLATE	X-6456	P3	W1
1	F	RELAY MOTOR	405NP1		
3	G	TERMINALS	367N5		
2	H	CONTACTS	404N18		
2	J	CONTACT ASSEMBLY	404N17		
14	K	#6 FLAT WASHER	310NFS6		
3	L	#4 SHAKEPROOF WASHER	373N701		
18	M	#6 SHAKEPROOF WASHER	373N702		
6	N	6-32 BRASS NUT	313N10EUBC35		
2	O	10-32 BRASS NUT	313N12GUBC4		
3	P	4-36 × 3/8 PH B H SCREW	343N6CVTP		
6	Q	6-32 × 7/16 PH B. H. SCREW	343N7EUTP		
6	S	6-32 × 3/4 PH B. H. SCREW	343N12EUTP		
2	T	6-32 × 7/8 SL B.H. SCREW	323N14EUBC		
1	U	10-32 × 3/8 SL B.H SCREW	323N6GUBC		
1	V	#10 SHAKEPROOF WASHER	373N704		

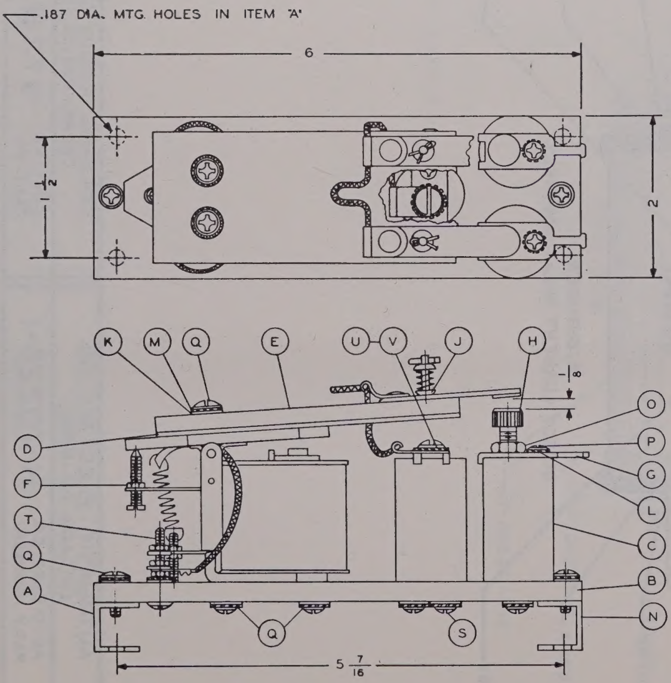
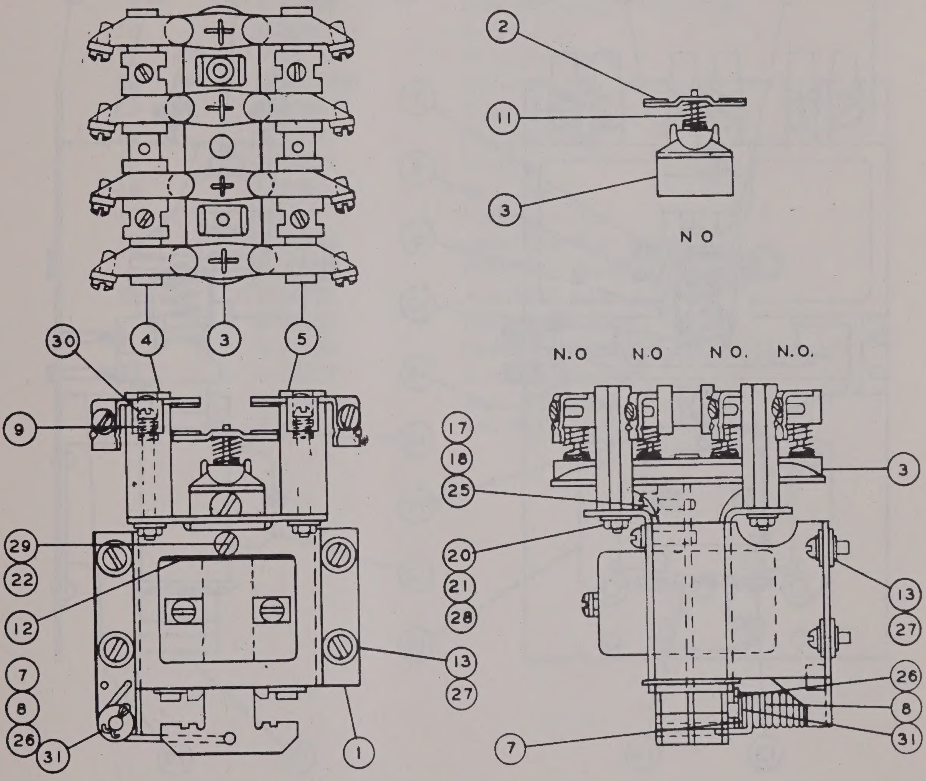


Fig. 120 Relay Assembly (K201)
(Dwg. No. 1524B)

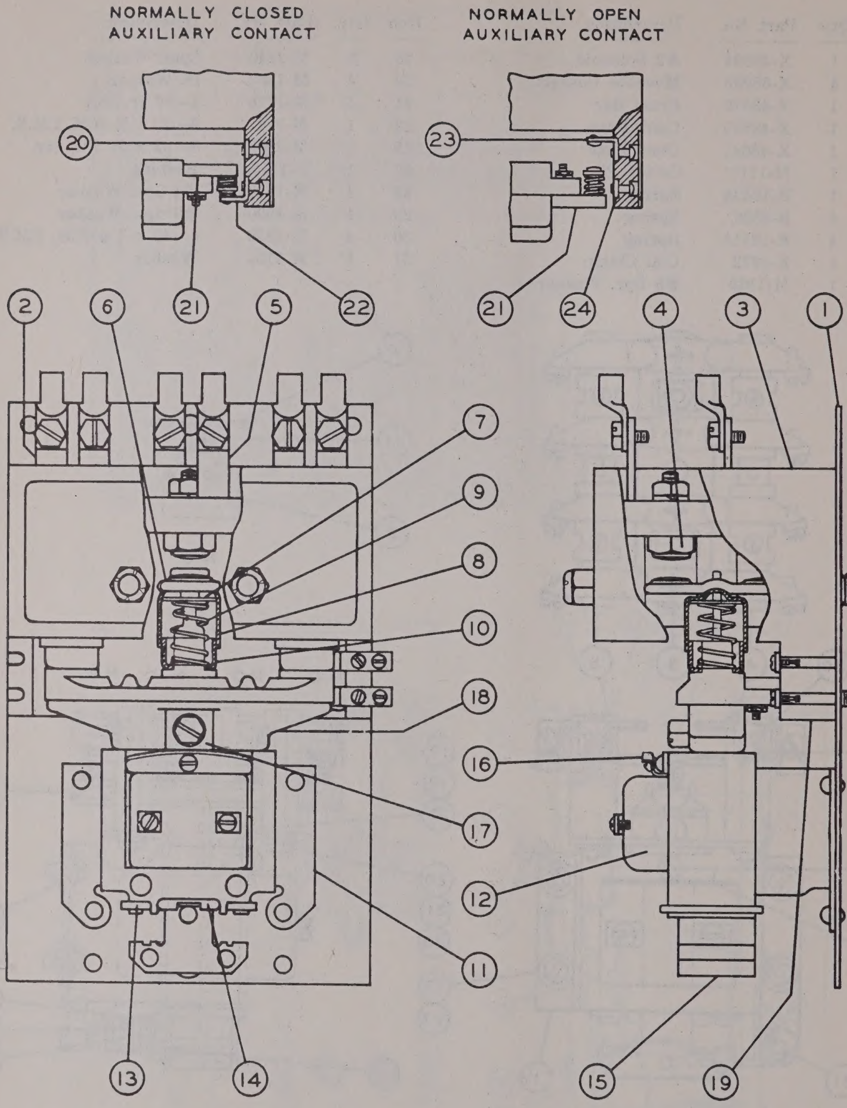
Item	Qty.	Part No.	Description
1	1	X-48504	#2 Solenoid
2	4	X-68996	Movable Contact
3	1	X-43576	Cross Bar
4	1	X-48680	Cont. Base
5	1	X-48681	Cont. Base
7	1	M-1112	Cotter Pin
8	1	B-10424	Spring
9	4	B-8590	Spring
11	4	E-10113	Spring
12	1	E-8672	Coil Clamp
17	1	M-1100	#8 Spr. Washer
18	1	M-2240	Spec. Washer
20	4	M-1309	Ir. Washer
21	4	M-1445	4—40 Ir. Nut
22	1	M-971	6—32 x ⅝ R.H. I.M.S.
25	1	M-2355	8—32 x ½ Fil. Scr.
26	1	B-11103	Bushing
28	4	M-1510	#4 Spr. Washer
29	1	M-1090	#6 Spr. Washer
30	4	M-1870	4—40 x 1⅛ R.H. I.M.S.
31	1	M-1155	Washer



ALLEN-BRADLEY COMPANY
MILWAUKEE WISCONSIN
ALLEN-BRADLEY PART NUMBER. BUL-700 B-400

COLLINS RADIO COMPANY
CEDAR RAPIDS IOWA
COLLINS PART NO: 405NA104

Fig. 121 Relay Assembly (K202)
(Dwg. No. 1798B)

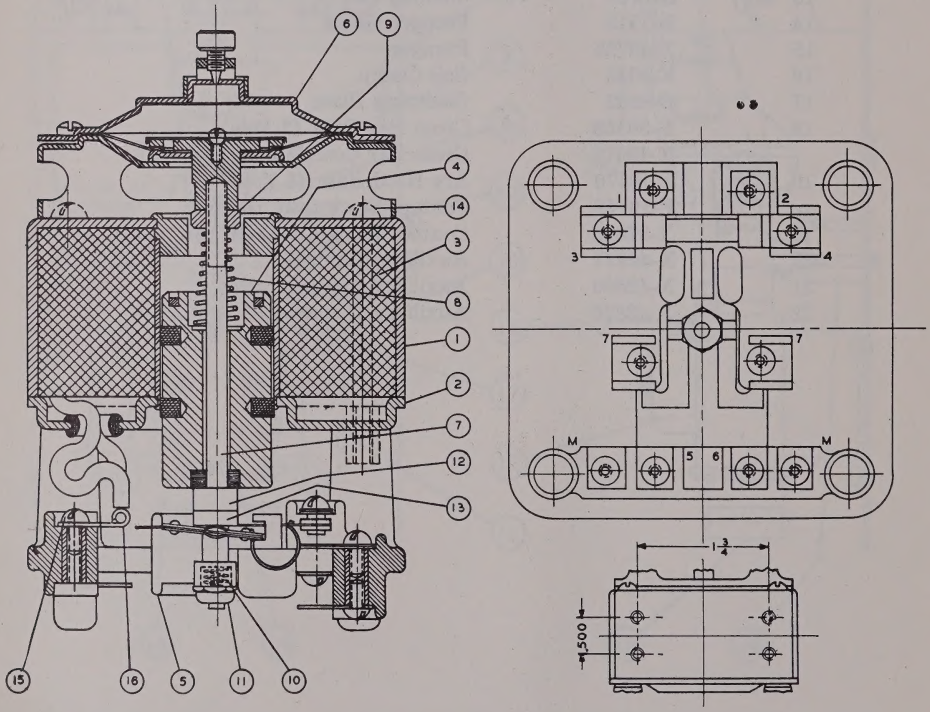


ALLEN-BRADLEY COMPANY MILWAUKEE, WISCONSIN	COLLINS RADIO COMPANY CEDAR RAPIDS, IOWA
ALLEN-BRADLEY NUMBER: BUL.-702 385804	COLLINS PART NO: 405NA2

Fig. 122 Relay Assembly (K203)
(Dwg. No. 1456B)

Item	Mfr's Part Number	Description
1	X-40561	Solenoid Base Assembly (3 Pole)
2	G-4089	Terminal (with Terminal Screw)
3	F-10771	Arc Hood Cover (3 Pole)
4	X-36702	Stationary Contact
	M-437	Stationary Contact Nut
5	G-4095	Terminal (with Terminal Screw)
	M-1801	Terminal Screw
6	X-36670	Movable Contact
7	M-2070	Special Washer
8	B-8236	Upper Cup
9	E-11095	Contact Spring (1-2-3 Pole)
10	B-8235	Lower Cup
11		Same as Item 1
12	RC-2-3606	Solenoid Coil
13	E-9769	Shading Coil
14	E-7718	Plunger Guide
15	X-49723	Plunger
16	E-9645	Coil Clamp
17	B-8232	Clamping Plate
18	X-36158	Cross Bar Only (3 Pole)
	X-49476	Cross Bar Complete (3 Pole)
19	F-10770	Arc Hood Base (3 Pole)
	F-10772	Contact Block Only (3 Pole)
	X-37853	Contact Block Complete (3 Pole)
20	X-42877	Auxiliary Contact
21	X-42560	Auxiliary Contact Lever
22	X-42876	Auxiliary Contact

Item	Qty.	Part No.	Description
1	1	1218-40	Coil Box Assembly
2	1	1218-157	Coil Box Cover Assembly
3	1	1218-139	Magnet Coil as Specified
4	1	1218-146	Magnet Core Assembly
5	1	1218-206	Terminal Block Assembly
6	1	1641-14	Timing Hand Assembly
7	1	1641-23	Spindle
8	1	1218-77	Conical Spring
9	1		#6—40 Hex. Lock Nut—Brass
10	1	1641-19	Spring
11	1	1641-20	Stop Nut
12	1	1645-02	Spacer
13	1	1641-11	Collar
14	4		#6—32 x 1½" R'd. H'd. Screw—Brass
15	2		#3—48 x $\frac{3}{16}$" R'd. H'd. Screw—Brass
16	2	C-841	Diamond Grip Lug



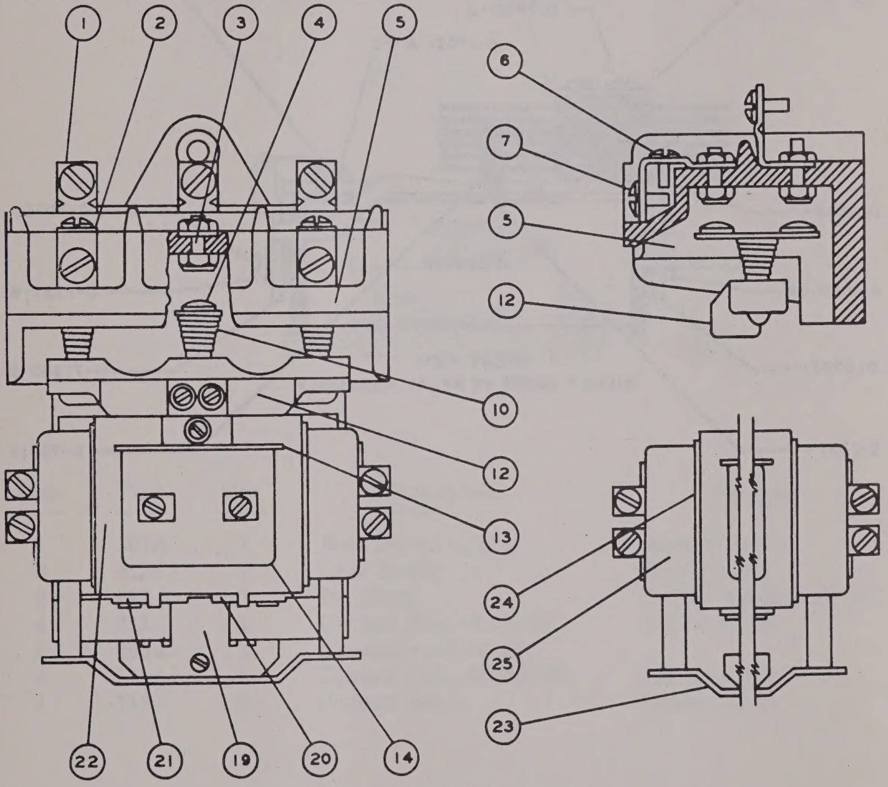
AMERICAN GAS ACCUMULATOR CO. ELIZABETH, NEW JERSEY	COLLINS RADIO COMPANY CEDAR RAPIDS, IOWA
ACCUMULATOR CO. NUMBER: NE-11 AC	COLLINS PART NO: 402000100

Fig. 123 Relay Assembly (K204)
(Dwg. No. 500 1553 00C)

Item	Qty.	Part No.	Description
1	3	G-3848	Terminal (with Term. Screw) **
2	3	G-4488	Terminal (with Term. Screw) **
3	3	X-33519	Front Stationary Cont.
	3	X-35163	Rear Stationary Cont.
	6	M-1891	Stationary Cont. Nut
4	3	X-33552	Movable Contact
5	1	X-49654	Contact Block Complete (3 N.O.)
6	3	M-1856	Terminal Screw
7	3	M-1552	Terminal Screw
10	3	B-10140	Contact Spring
12	1	X-32836	Cross Bar Only (3 N.O.)
13	1	E-8676	Coil Clamp

** Unless terminal markings are specified, these parts will be furnished without markings.

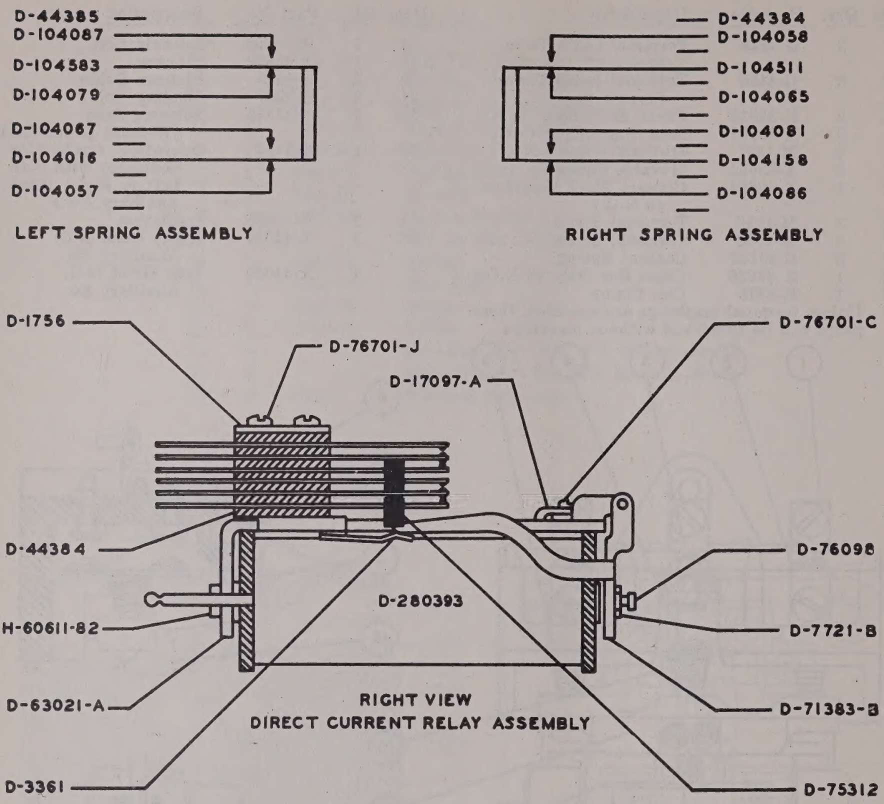
Item	Qty.	Part No.	Description
14	1	RC-3406	Solenoid Coil
19	1	X-62599	Plunger
20	1	E-8675	Plunger Guide
21	2	E-9257	Shading Coil
22	1	X-32375	Solenoid Base (Without Grommets)
23	1	E-9387	Operating Angle (for Contactor with both Left & Right Hand Auxiliary Sw.)
24	2	F-11053	Insulation
25	1	X-44040	Right Hand N.O. Auxiliary Sw.
	1	X-44050	Left Hand N.O. Auxiliary Sw.



ORDER COMPLETE RELAY BY COLLINS PART NUMBER

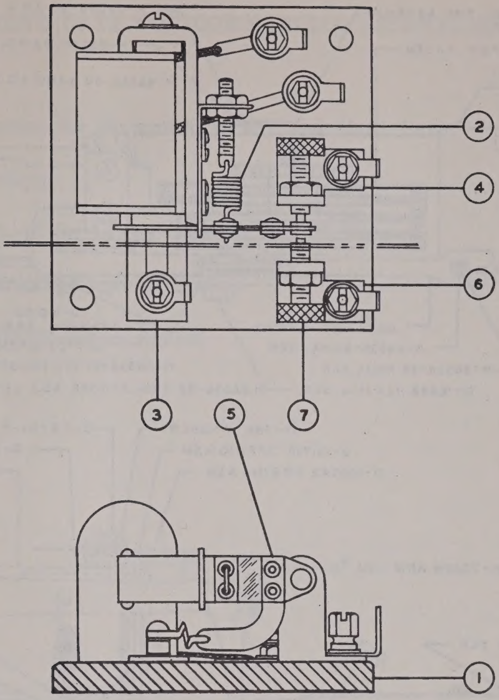
ALLEN-BRADLEY COMPANY MILWAUKEE WISCONSIN	COLLINS RADIO COMPANY CEDAR RAPIDS IOWA
ALLEN-BRADLEY NUMBER. BUL.702 #379,646	COLLINS PART NO 405NA1

Fig. 124 Relay Assembly (K205)
(Dwg. No. 959B)



AUTOMATIC ELECTRIC CO. CHICAGO ILLINOIS	COLLINS RADIO COMPANY CEDAR RAPIDS IOWA
AUTO. ELEC. CO. PART NUMBER: H-70226-21	COLLINS PART NO: 972N7

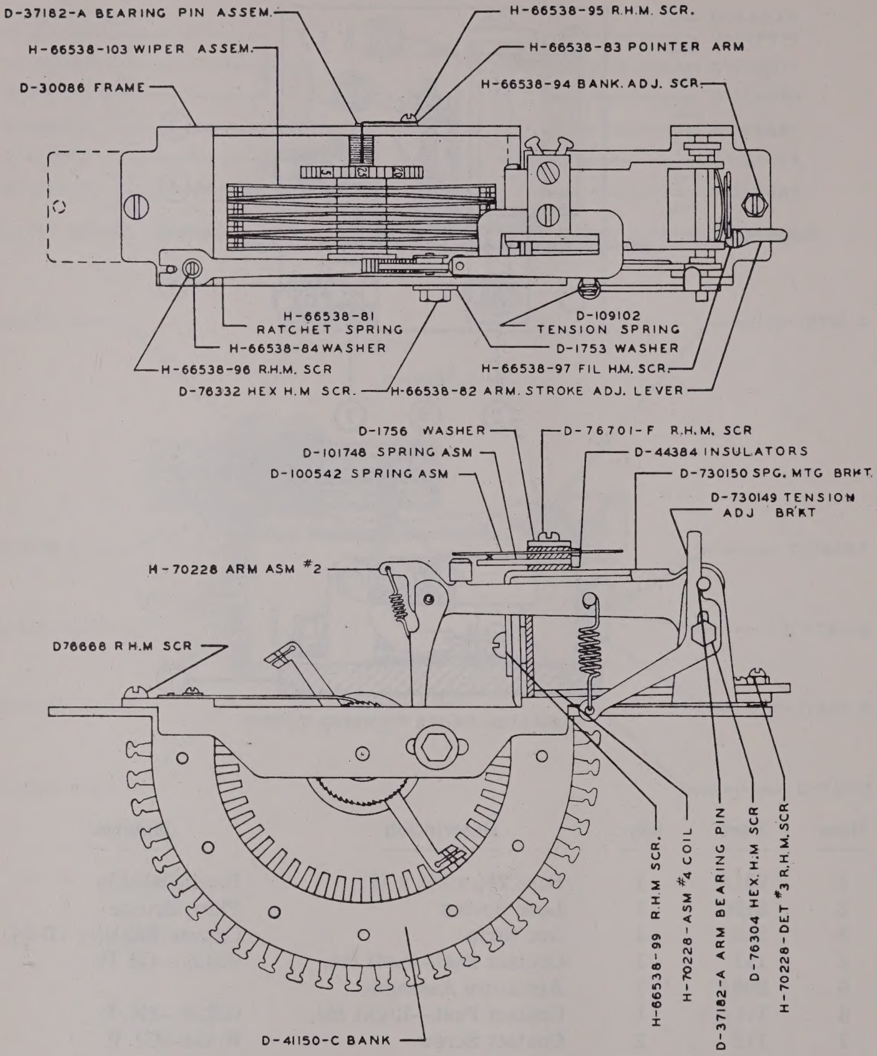
Fig. 125 Relay Assembly (K301)
(Dwg. No. 969B)



Item	Part	Qty.	Description	Material
1	201A	1	Base 2⅝ x 2⅝ x ¼	Black Bakelite
2	212C	1	Load Spring	Phos. Bronze
3	213	1	Ins. Strip	Canvas Bakelite (D-34)
4	111	1	Contact Post—Left Hd.	C.R.S.—Cd. P.
5	205A	1	Armature Assembly	
6	111A	1	Contact Post—Right Hd.	C.R.S.—Cd. P.
7	112	2	Contact Screw	Brass—Cd. P.

KURMAN ELECTRIC CO., INC. NEW YORK CITY, NEW YORK	COLLINS RADIO COMPANY CEDAR RAPIDS, IOWA
KURMAN NUMBER: 223C38A	COLLINS NUMBER: 408N7

Fig. 126 Relay Assembly (K302, K401, K402)
(Dwg. No. 574B)



AUTOMATIC ELECTRIC CO. CHICAGO ILLINOIS	COLLINS RADIO COMPANY CEDAR RAPIDS IOWA
AUTO-ELEC CO NUMBER: H-70228-1	COLLINS PART NO: 978N2

Fig. 127 Rotary Switch Assembly (S113)
(Dwg. No. 774C)

APPENDIX

ADJUSTMENT DATA FOR COMMERCIAL ASSEMBLIES

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Adjustment for 978N1 Telephone Dial 255

Adjustment for 978N2 Rotary Switch 257

APPENDIX

STANDARD ADJUSTMENT FOR HORIZONTAL RELAYS AND SHORT LEVER ARMATURE RELAYS

A—GENERAL:

1. **Definitions:** Various terms used in the requirements through this standard adjustment will have the following meanings:

   "Spring Combination" is the entire spring assembly of either a single or double armature relay.

   "Spring Pile-up" is an assembly of all the springs operated by one armature arm. "Contacts Springs" are the individual springs of a spring pile-up or a spring combination.

   "Two step operation relays" are relays having separate electrical requirements for one or more pairs of contact springs.

2. When a "Z" relay is mounted on the frame of a Strowger switch, the relay armature shall clear the nearest point on the lower rotary magnet coil spool head by minimum $1/32$".

3. On break combinations disk type contacts shall not be out of alignment (gauged visually) by more than $1/5$ of their face diameter, and in their normal position shall be engaged by not less than $1/2$ the area of the contact faces. (A barely perceptible gap caused by contact face irregularities, etc., shall be regarded as a closed contact.)

4. On make combinations disk type contacts shall not be out of alignment (gauged visually) by more than $1/5$ of their face diameter, and shall be engaged by not less than $1/2$ the area of the contact faces during some part of the stroke.

B—ALIGNMENT:

1. When relays are mounted on their associated mounting plates, the relays shall be well aligned. There shall be a minimum space of $1/32$" between the armature or springs of any relay and the armature, springs, or heelpiece of the relay above or below it, and the armature back stop of any relay shall not touch the heelpiece of the relay above it. This may be gauged by eye.

2. In either the normal or operated position, there shall be a clearance of .010" minimum between springs not designed to make contact.

3. All contact springs, when assembled on the relay, shall line up uniformly with respect to each other and to the relay structure proper as gauged by eye.

4. Spring operating bushings shall be approximately in alignment with the center of and perpendicular to the springs against which they strike, as gauged by eye.

C—ARMATURE:

1. The relay armature shall be set so as not to make contact with the heelpiece, but so as to clear the heelpiece by not more than .003" for adjustment and .004" for inspection at the closest point with the armature operated, unless otherwise specified. The armature shall be parallel to the heelpiece end, as gauged by eye.

   NOTE: In case of short lever slow release relays, the maximum air gap may be .005" for adjustment and .006" for inspection.

2. The relay armature shall not bind at its bearings or on the heelpiece and shall have side play of maximum .020", minimum .002".

3. The armature back stop shall be adjusted to allow perceptible play in the armature between the #2 spring and the armature back stop in spring pileups where the #1 spring is a back contact.

STANDARD ADJUSTMENT FOR HORIZONTAL RELAYS AND SHORT LEVER ARMATURE RELAYS

4. The "Z" relay armature back stop shall be positioned so that the point of contact between the armature and the formed edge of the back stop is $\frac{1}{32}$″ minimum from the end of the armature arm.

5. The armature bushing shall be securely assembled on its associated mounting.

   NOTE: This requirement shall be considered as having been met if the bushing is forced onto the mounting lug with a pressure of minimum 20 lbs. while the bushing is at an approximate temperature of 200° F.

D—RESIDUALS:

1. This is an adjustment of the space between the core and the armature with the relay electrically operated.

2. Where the residual specified on the Relay Adjustment Sheet is .003″ or more, a tolerance not to exceed plus or minus .001″ for adjustment and .002″ for Inspection shall be allowed unless otherwise specified.

3. Where the residual is specified as .0015″ the armature shall not touch the core nor be over .003″ for Adjustment and .004″ for Inspection from the core at the closest point, with the armature operated electrically.

E—SPRINGS:

1. Relays shall be gauged between the armature (or residual screw when used) and core, with the armature operated electrically.

2. For adjustment plus or minus less than .001″ in the case of standard armatures, or .002″ in the case of short lever armatures, variation from the values specified shall be allowed unless otherwise specified.

3. Upon inspection, plus or minus less than .002″ in the case of standard armatures, or .003″ in the case of short lever armatures, variation from the values specified shall be allowed unless otherwise specified.

   (a) When a make or break contact is specified as .033″, or less, the variation allowed for Adjustment shall be plus less than .001″ or minus – 0 – and for Inspection shall be plus less than .002″ or minus – 0 –.

   (b) When a make or break contact is specified as .004″ the variation allowed for Adjustment shall be plus less .001″ or minus less than .001″ and for Inspection shall be plus less than .002″ or minus less than .001″.

   (c) On make-before-break assemblies where the difference between the values specified for the make and break adjustment is as indicated in the following table, the variation allowed for Inspection or Adjustment as determined by E2, E2(a) or E2(b), shall not cause the break contacts to break when a gauge is used which is the indicated amount smaller than the gauge on which the make contacts actually make:

Difference between make and break specified	Break contacts shall not break with following size gauge smaller than gauge on which contact actually makes.	
	For Inspection	For Adjustment
.003″ and .004″ for slug Type C Relay of selectors	.001″	.002″
.003″	.002″	.003″
.004″	.002″	.003″
.005″	.003″	.004″
.006″	.004″	.005″
.007″	.005″	.006″
.008″	.006″	.007″

These tolerances shall be checked with gauges which vary in steps of .001″.

STANDARD ADJUSTMENT FOR HORIZONTAL RELAYS AND SHORT LEVER ARMATURE RELAYS

(d) Where a stroke measurement is specified, the variation allowed for inspection shall be as follows:

1. A gauge .003″ in the case of a standard armature and .005″ in the case of a short lever armature larger than the specified stroke gauging should not enter between the armature (or residual screw when used) and the core when the relay is not energized, or if it does enter the armature shall not leave the armature back stop when the relay is electrically energized.

2. When the difference between the values specified for stroke gauging and the highest make contact gauging is .005″ or more, the armature shall leave the back stop when a thickness gauge of .002″ less than the values specified for the stroke is inserted between the armature (or residual when used) and the core.

3. When the difference between the values specified for the stroke gauging and the highest make contact gauging is .004″ or less, the armature shall leave the back stop when a thickness gauge of .002″ more than the value on which the make contact actually makes, (gauged within .001″), is inserted between the armature (or residual screw when used) and the core.

(e) When there are two or more back contacts in spring pile-ups, the variation allowed shall not change the sequence of operation, as indicated by the specified mechanical gauging.

NOTE: The above requirements do not apply to the back contacts of the standard make-before-break assemblies as illustrated by springs #2 and #3 of Figure 7.

(f) When the gauging specified for a make contact assembly is .004″, or more, greater than any other make contact gauging value for the same relay, no variation shall be allowed that will alter the sequence of operation indicated by the .004″ or more difference.

(g) When the difference between the values specified for the break and make springs of a break-make assembly is .002″ or less the make springs shall not make when a gauge is used which is .002″ less for Adjustment or .001″ less for Inspection, than that on which the break contacts actually break. When the difference between the values specified for the break and make springs of a break-make assembly is .003″ or more, the make springs shall not make when a gauge is used which is .002″ less than that on which the break contacts actually break.

4. When the gauging or separate electrical requirements indicate that one or more pairs of contacts shall make or break before the next succeeding pair of contacts break, they shall be adjusted as follows:

(a) When the gauging difference between the pairs of contacts is .006″ or more, the make or break contacts shall make or break before the bushing on the armature spring of the succeeding pair of break contacts is struck by the preceding armature spring.

(b) When the gauging difference between the pairs of contacts is .005″ or less, the make or break contacts may or may not make or break before the bushing on the armature spring of the succeeding pair of break contacts is struck by the preceding armature spring, but the make or break contacts must make or break before the succeeding break contacts break.

5. Variation in the mechanical gauging shall not be permitted which will allow the normal or operated contact gap to be less than .005″ as gauged by eye.

STANDARD ADJUSTMENT FOR HORIZONTAL RELAYS AND SHORT LEVER ARMATURE RELAYS

6. Unless otherwise specified, relays shall fully operate all springs and the armature (or residual screw when used) shall touch the core on the "Operate" tests shown on the Relay Adjustment Sheet.

7. Unless otherwise specified, relays shall not open any back contact circuits nor close any make contact circuits on the "non-operate" tests shown on Relay Adjustment Sheets except as follows:

   (a) On relays having three or more back contacts the first two back contact assemblies in the sequence of operation, as indicated by the specified mechanical gauging, may break contact on the "non-operate" tests.

   NOTE: The above requirement does not apply to the back contacts of the standard make-before-break assemblies as illustrated by springs #2 and #3 of Figure 7. However, the above requirement applies to the back contacts of the special make-before-break assemblies as illustrated by springs #1 and #2 of Figure 8.

   (b) On special make-before-break contact springs as illustrated by Figure 8, the make contacts may make on the non-operate requirements specified for the entire spring combination.

   (c) On two step relays the contact to which the separate electrical requirements apply may make or break on the "non-operate" requirements specified for the entire spring combination.

8. Spring tension shall be accurately adjusted in accordance with the "Adjust" values (current or resistance) and inspected in accordance with the "Test" values (current or resistance) shown on the Relay Adjustment Sheets.

9. A variation of plus or minus one volt shall be allowed on the voltage specified for adjusting and inspecting the relays according to the "Adjust" and "Test" resistance values.

F—SATURATION:

1. Relays shall be saturated at a minimum of 300 ampere turns for an interval of minimum one second before being adjusted or checked to the electrical current flow requirements unless otherwise specified. The saturating current shall be in the same direction as the other current flow requirements unless otherwise specified. The other current flow requirements shall not be applied until an interval of minimum one second after saturation.

   (a) This requirement may be met by applying voltage to the operating winding of the relays as follows: Windings of 100 ohms resistance or more, connect directly to 46 volts ±1 volt. Windings of less than 100 ohms resistance, connect to 46 volts ±1 volt with a protective resistance of approximately 45 ohms (or switch magnets) in series.

G—LOCKING TYPE RELAYS:

1. With the armature at normal, the pressure of the locking spring against the armature shall be minimum 75 grams, maximum 150 grams for Adjustment and minimum 50 grams, maximum 200 grams for Inspection.

   2. The locking spring shall latch the armature when the armature is manually operated with .0015″ between the core and the armature (or residual screw when used), and shall not latch the armature without binding when the armature is manually operated with .003″ between the core and armature (or residual screw when used).

3. The tongue of the locking spring shall en-

gage the armature to a depth at least equal to the thickness of the tongue.

H—STROKE ADJUSTMENT OF 3 POLE RELAYS, WITH STROKE ADJUSTING SCREW:

The front pole-piece shall be located so as to be approximately flush with the edge of the center pole-piece as gauged by eye.

The armature travel is adjusted with the aid of the screw and lock nut located in the front pole-piece. When the armature travel has been set the position of the screw shall be secured by tightening the lock nut. The end of the screw shall extend a minimum of .030″ beyond the inside surface of the front pole-piece.

NOTE: In case of large armature travels it may be necessary in order to meet the above .030″ requirement, to reset the front pole-piece further toward the armature end of the relay.

J—LUBRICATION:

1. Whenever a horizontal relay is to be operated as much as one million times a year, it is recommended that the armature bearings be lubricated by a #4 Artist's Sable Rigger brush which has been dipped 3/8″ into spindle oil and scraped on the edge of the container to remove surplus oil. There should not be sufficient oil adhering to the brush to form a drop on the end at the bristles. Six relays may be oiled with one such "dip."
2. During manufacture, relays shall be oiled only when the adjustment sheets or cards carry a note "Oil Bearings."

APPENDIX

STANDARD ADJUSTMENT FOR LEVER KEYS

A—GENERAL:

1. Keys shall meet the general requirements specified in Standard Adjustments for General Requirements that are applicable.

B—SPRINGS:

1. The tips of lever springs which have associated back contacts shall be adjusted to clear their respective rollers by minimum perceptible, maximum .005″ with all the play in the key lever taken up in the direction away from the spring tips which are being gauged.
2. The tips of lever springs shall contact the entire width of their respective rollers when the key is operated.
3. With the key at normal, the formed lever spring of any pile-up shall rest against either a back contact or an insulator with a tension of minimum 50 grams measured at the form.
4. A lever spring not having a back contact shall be tensioned against its adjacent lever spring or against the insulator with a minimum pressure of 20 grams measured at the tip of the spring when the key is normal.
5. Break contacts in a spring pile-up shall break in sequence, the break contact nearest the key frame opening first.
6. Unless otherwise specified all the break contacts on one side of a key except the break contacts of make-before-break assemblies, shall open before any make contact closes, including makes of make-before breaks.
7. Break contact springs shall have a minimum follow of .010″ when breaking contact.
8. Make contact springs shall have a minimum follow of .015″ after making contact.
9. The normal contact separation of make or break contacts shall be minimum .010″.
10. There shall be a clearance of minimum .010″ between terminals of the same key or between terminals of adjacent keys.
11. There shall be a minimum of 1/32″ between springs in adjacent spring pile-ups.
12. On A.E. Co. type lever keys, there shall be a clearance of not less than .005″ between the lever springs and the key frame when the key is in the normal position.

C—ROLLERS:

1. Rollers shall turn freely when the key is being operated.
2. Rollers shall not have perceptible bind on the frame when the key is being operated.

D—HANDLES:

1. Key handles shall seat on shoulders of cam.
2. Handles of adjacent keys shall be in approximate alignment.

PUSH KEYS TYPE D-59094-A

E—SPRINGS:

1. There shall be just perceptible clearance between the roller bushing and the main springs when the key is in the normal position.
2. The normal contact separation of make contacts shall be not less than .015″ and shall allow the make contact to "follow" not less than 1/64″ after making contact.

F—ROLLER PLUNGER ASSEMBLY:

1. The roller bushing shall turn freely on its bearing.
2. The main rollers shall turn freely while the key is being operated.
3. The assembly shall not bind and shall restore to normal with the tension of the contact springs removed.

ADJUSTMENT FOR 978N1 TELEPHONE DIAL

A—GENERAL:

1. The dial shall meet the general requirements specified in Standard Adjustments for General Requirements which are applicable.
2. The finger plate shall not bind on the finger stop.
3. The enamel on the number plate shall be clean and shall not be broken or excessively cracked.

B—IMPULSE SPRINGS:

1. When not engaged by the impulse shorting arm, the middle impulse spring shall rest firmly against the heavy stop spring from its own tension.
2. With the finger plate off normal and the tip of the main impulse spring opposite a low side of the cam, the main impulse spring shall rest against the contact of the middle spring with minimum 25 grams, maximum 50 grams contact pressure.
3. With the finger plate off normal and the tip of the main impulse spring opposite a low side of the cam, the heavy stop spring shall hold the middle and main impulse springs so as to make the separation between the main impulse spring and a low side of the impulse cam approximately the same as the space between contacts when the main impulse spring is resting against the high side of the cam.

C—MAIN SPRING AND SHUNT SPRINGS:

1. The main spring shall have one to one and a third turns tension with the dial at normal.
2. When an impulse shorting arm is used, the plane parallel to the dial mounting plate which passes through the center line of the buffer on the middle impulse spring shall pass through a point within the width of the contacting portion of the impulse shorting arm.
3. The impulse shorting arm, when used, shall cause the main impulse spring to clear the cam by minimum .015″, maximum .030″ during the shorted impulse.
4. The impulse shorting arm shall not cause the impulse springs to move until after the completion of the last pulse sent out.
5. Shunt springs shall be tensioned so that as the dial returns to normal or moves off normal each spring will make contact with its adjacent spring while traveling through a space of not less than .015″.
6. Contact separation for shunt springs either in their operated or normal position shall be from .015″ to .030″.
7. The main spring of a break-make combination shall break contact from its back contact before making contact at its front contact.

   NOTE: This requirement also applies to three springs of a four-spring combination when the operating spring opens a back contact and closes a make contact.
8. When there are two break contacts (normally open) in the shunt spring assembly, springs 1 and 2 shall break contact before springs 3 and 4 break contact. There shall not be more than perceptible clearance (if any) between the bushings of spring 4 and spring 2.
9. The shunt spring operating cam width shall be aligned within the width of the buffer on the operating shunt spring in the normal position with respect to shaft end play.

   NOTE: Alignment shall be such that contact gap is min. .005″ when dial finger plate is pulled out when at normal.

ADJUSTMENT FOR 978N1 TELEPHONE DIAL

D—GOVERNOR:

1. There shall be perceptible end play in the governor but this end play shall not exceed 1/64″.
2. The governor wings shall be formed as nearly as possible alike.
3. The dial shall operate at a speed of not less than eight impulses per second nor more than twelve impulses per second unless otherwise specified on the assembly drawing.

E—RATCHET:

1. With the dial at normal the pawl shall rest against its stop so as to give minimum .008″ maximum .030″ clearance between the shaft stop arm and its associated stop.

F—OPERATION:

1. The dial shall operate freely as it restores to normal.

   NOTE: Tests for sticking shall be made as follows: Pull the "one" toward the finger stop until the pawl engages the next tooth of the ratchet and allows the dial to return to normal. Repeat once. Pull the "three" to the finger stop and release. Then pull the "six" and finally the "0". If the dial does not stick the requirement is satisfactorily met.

G—LUBRICATION:

1. One drop of watch oil (see Specification 5228) shall be applied to each of the following parts during manufacture and for maintenance:

   NOTE: A drop of oil shall be considered to be the amount released from a piece of number 22 B&S gauge, bare tinned copper wire after it has been dipped 1/2″ into the lubricant and quickly withdrawn.

   (a) Worm wheel shaft bearings.

   (b) Governor shaft bearings.

   (c) Pawl bearing.

2. One dip of watch oil shall be applied to the following parts during manufacture and for maintenance:

   NOTE: A dip of oil shall be considered to be the amount retained in a #4 Artist's Sable Rigger brush after being dipped in the lubricant to a depth of 3/8″ and then scraped on the edge of the container to remove surplus oil. There should not be sufficient lubricant adhering to the brush to form a drop at the end of the bristles.

   (a) Dial shaft bearings.

   (b) Main gear wheel bearing.

   (c) Exposed portion of main bearing on governor side of mounting plate. (Cover this surface with a film of oil for rust protection.)

   (d) Governor shaft worm.

3. One dip of light mineral oil shall be applied to the following parts during manufacture and for maintenance:

   (a) Ratchet teeth on main gear.

   (b) Cam (apply to the edge of the cam and then wipe off the surplus oil).

   (c) Fibre buffers (when used) on shunt or impulse springs. Apply to the fibre and then wipe off the surplus oil.

   NOTE: Oil is not to be applied to the hard rubber buffers.

4. Excessive oil shall not be allowed to remain on any surface.

ADJUSTMENT FOR 978N1 TELEPHONE DIAL

H—SPECIAL REQUIREMENTS FOR OPERATION AT LOW TEMPERATURES:

The following special requirements shall apply to dials which are exposed to cold weather.

1. The main spring shall be adjusted to the maximum tension specified in C-1 (one and one-third turns).
2. The minimum speed requirement of D-3 shall be increased from eight impulses per second to ten impulses per second (at approximately 70° F.) for all dials with a nominal speed of ten impulses per second.
3. Before lubrication, all bearings and gears, the governor cup, governor weights, and dial shaft shall be thoroughly washed with a liberal amount of carbon tetrachloride. All loose dirt and dust shall be removed from the dial parts. All parts shall then be lubricated in accordance with Section G except that watch oil shall be substituted for the light mineral oil specified in G-4. No oil other than watch oil shall be permitted upon any part of the dial.

APPENDIX

ADJUSTMENT FOR 978N2 ROTARY SWITCH

A—GENERAL:

1. The switch shall meet the general requirements specified in Standard Adjustments for General Requirements which are applicable.
2. The armature stop and ratchet spring shall always be loosened before making adjustments to meet requirements C and D.

B—BRUSH SPRINGS:

1. The brush springs (wiper terminal springs) shall be tensioned and curved so that with all pressure relieved, the ends of the two springs in a pair shall be separated approximately ¼″ and when assembled in the wiper assembly the two springs will close to within approximately ¼″ of their ends.

C—PAWL STOP:

1. The edges of the rotary pawl along its length shall be parallel to the sides of the ratchet wheel, and the tip of the pawl shall be parallel to the outer edge of the ratchet teeth as gauged by eye.

D—WIPER ALIGNMENT:

1. The edge of the bridging or private wiper shall be approximately in alignment with the front edge of contacts #1 and #25 and the edge of the non-bridging or line wipers shall rest from ¼ and ½ of the contact width ahead of the front edge of contacts #1 and #25.
2. With the wiper assembly in any normal position of rest, the bridging or private wipers shall not bridge adjacent contacts within 1/64″.

   NOTE: The above requirements are adjustments of the pawl stop and bank adjusting screw.

E—ARMATURE STOP:

1. After requirements C and D have been met, the armature stop shall be set to relieve the pressure of the pawl against the pawl stop.
2. The armature stop shall allow play in the wiper assembly when the armature is against the stop and is engaging any ratchet tooth. This play shall be just perceptible on at least one tooth.

F—RATCHET SPRING:

1. The tip of the ratchet spring shall clear the radial surface of each ratchet tooth with the armature against the armature stop.
   - (a) The above clearance shall not exceed .004″.
2. The ratchet spring shall be tensioned to have a pressure against the ratchet teeth of 50 grams minimum to 125 grams maximum measured at the curve near the tip of the spring.

G—ARMATURE:

1. The armature shall not bind on its bearing nor on the bearing pin locking spring.
2. The pawl shall not bind on its bearing nor on the switch frame.
3. The pawl spring shall cause the tip of the pawl to rest firmly against the ratchet when the armature is operated.
4. The contact spring operating bushing shall fit tightly on the armature and shall have minimum two-thirds of its width opposite the associated springs.
5. The spring washer shall hold the armature stroke adjusting screw securely in place.
6. The stroke adjusting screw shall be set so that the pawl just drops in on the next

ADJUSTMENT FOR 978N2 ROTARY SWITCH

tooth without binding on the tip of the tooth when there is .002″ between the screw and coil core and does not drop in without binding with .005″ between the screw and coil core.

(a) The above conditions shall be determined by moving the pawl from one tooth to the other by hand, with the magnet energized directly on the nominal voltage (46 volts, usually).

H—MOTOR MAGNET SPRING:

1. When the first contact is a make contact the combined tension of the contact springs and the armature driving spring shall be adjusted in accordance with the associated relay adjustment sheet. The armature spring shall rest against the armature bushing with 25 grams minimum, 75 grams maximum pressure, measured where the armature spring strikes the bushing.

I—WIPER ASSEMBLY:

1. The wiper assembly shall turn freely on its bearings.
2. The backs of all wipers shall be slightly flared.
3. The sets of wipers shall be aligned so that they pass onto the base of brush terminals without excessive movement to one side or the other.

   NOTE: With this adjustment, the wiper springs of the first level shall clear the pawl and pawl stop by minimum 1/64″ during rotation.

4. Each spring of a wiper having a broad flat tip for contact surface shall be tensioned to follow approximately 3/32″ measured at the tip when its opposing spring is deflected.
5. Each spring of a wiper having a knife edge contact shall be tensioned to follow approximately 1/16″ measured at the tip when its opposing spring is deflected.
6. The indicator shall point to the number or line on the indicating wheel corresponding to the bank contacts on which the wipers are resting.

J—LUBRICATION:

1. One drop of spindle oil shall be applied to each of the following parts:

   NOTE: A drop of oil shall be considered to be the amount released from a piece of number 22 B&S gauge, bare tinned copper wire after it has been dipped 1/2″ into the lubricant and quickly withdrawn.

   (a) Armature bearings (between the armature and the frame for the regular type switch and on both sides of each armature bearing for the heavy duty type).

   (b) Pawl bearing.

   (c) Wiper assembly bearings (bearing screw type).

2. Two dips of Switch Lubricant shall be applied to the ratchet teeth with the wiper assembly rotating to distribute the lubricant.

   NOTE: One dip of oil is defined as the amount of oil retained by a #4 Artist's Sable Rigger brush after being dipped into the oil to a depth of approximately 3/8″ and then scraped on the edge of the container to remove the surplus oil.

3. The wipers and bank shall be lubricated by distributing one dip of spindle oil between the wiper tips of one end of three pairs of wiper springs. Both ends of the wiper springs shall be lubricated; i.e., a three

ADJUSTMENT FOR 978N2 ROTARY SWITCH

level wiper assembly would require two dips of oil, one for each end. Rotate the switch after applying the lubricant to distribute the oil on the bank.

4. Hollow shaft type wiper bearing; apply #33 Alemite Lubricant to end portion of the bearing pin opposite link and approximately fill center or under cut portion. Assemble the bearing pin without causing the lubricant on the center portion to drop off. (Machine Oil is satisfactory for maintenance if desired.)
5. Excessive oil shall not be allowed to remain on any surface.

APPENDIX

TUBE DATA

Type	Symbol Designations
6A8	V101, V111
6AG7	V102
6C8G	V302, V303
6SJ7	V109, V304, V401
6SL7GT	V301, V110
6SN7GT	V113, V305, V402
6X5GT	V306, V403
450TL	V311, V312
750TL	V114, V115
801	V307, V308
807	V103, V104
811	V116
813	V105, V106
845	V309, V310
866/866A	V207, V208, V209, V210
872A	V201, V202, V203, V204, V205, V206
VR150-30	V107

WARNING: In order to obtain satisfactory tube life the following precautions must be taken:

1. Operate all tube filaments within ±5% of rated voltage.
2. Do not exceed rated plate current in any of the tubes during normal operation of the equipment.
3. When tuning, do not exceed rated plate current except for periods of short duration.

Failure to observe the above precautions may result in the destruction of the tubes.

ALL TUBES SUPPLIED WITH THE EQUIPMENT OR AS SPARES ON THE EQUIPMENT CONTRACT SHALL BE USED IN THE EQUIPMENT PRIOR TO EMPLOYMENT OF TUBES FROM GENERAL STOCK.

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6A8, 6A8-G, 6A8-GT

PENTAGRID CONVERTER

Heater[■]	Coated Unipotential Cathode			
Voltage	6.3		a-c or d-c volts	
Current	0.3		amp.	
Direct Interelectrode Cap.°	*6A8*	*6A8-G*	*6A8-GT*	
Grid #4 to Plate	0.06	0.26	0.26	μμf
Grid #4 to Grid #2	0.1	0.19	0.19	μμf
Grid #4 to Grid #1	0.09	0.16	0.16	μμf
Grid #1 to Grid #2	0.8	1.1	1.1	μμf
Grid #4 to All Other Electrodes (R-F Input)	12	9.5	9.5	μμf
Grid #2 to All Other Electrodes Except Grid #1 (Osc. Output)	5	4.6	4.6	μμf
Grid #1 to All Other Electrodes Except Grid #2 (Osc. Input)	6.5	6	6	μμf
Plate to All Other Electrodes (Mixer Output)	12	12	12	μμf
Overall Length	3-1/8" max.	4-7/32" to 4-15/32"	3-5/16" max.	
Seated Height	2-9/16" max.	3-21/32" to 3-29/32"	2-3/4" max.	
Maximum Diameter	1-5/16"	1-9/16"	1-5/16"	
Bulb	Metal Shell, MT-8	ST-12	T-9	←
Cap	Miniature	Skirted Min.	Skirted Min. Style C	

[■] In circuits where the cathode is not directly connected to the heater, the potential difference between heater and cathode should be kept as low as possible.

° With shell of 6A8 connected to cathode, and with close-fitting shield on 6A8-G and 6A8-GT connected to cathode.

← Indicates a change.

6A8, 6A8-G, 6A8-GT

PENTAGRID CONVERTER

(continued from preceding page)

	6A8	*6A8-G*	*6A8-GT*
Base	Small Wafer Octal 8-Pin	Small Shell Octal 8-Pin	Small Wafer Octal 8-Pin, Sleeve
Basing Designation	8A	G-8A	GT-8A

Pin 1 { 6A8, Shell
6A8-G, No Con.
6A8-GT, Base Sleeve

Pin 2 – Heater

Pin 3 – Plate

Pin 4 – Grids #3 & #5

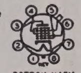
Pin 5 – Grid #1

Pin 6 – Grid #2

Pin 7 – Heater

Pin 8 – Cathode

Cap – Grid #4



BOTTOM VIEW

Mounting Position Any

CONVERTER SERVICE

Plate Voltage	300 max.	volts
Screen (Grids #3 & #5) Voltage	100 max.	volts
Screen Supply Voltage	300 max.	volts
Anode-Grid (Grid #2) Voltage	200 max.	volts
Anode-Grid Supply Voltage*	300 max.	volts
Control-Grid (Grid #4) Voltage	0 min.	volts
Plate Dissipation	1.0 max.	watt
Screen Dissipation	0.3 max.	watt
Anode-Grid Dissipation	0.75 max.	watt
Total Cathode Current	14 max.	ma.

Typical Operation:			
Plate Voltage	100	250	volts
Screen Voltage	50	100	volts
Anode-Grid Voltage	100	–	volts
Anode-Grid Supply Voltage	–	250*	volts
Control-Grid Voltage	-1.5	-3	volts
Osc.-Grid (Grid #1) Resistor	50000	50000	ohms
Plate Resistance	0.6	0.36 approx.	ohms
Conversion Transconductance	360	550	μmhos
Conver. Transcond. (approx.) with Control-Grid Bias of -20 volts	3	–	μmhos
Conver. Transcond. (approx.) with Control-Grid Bias of -35 volts	–	6	μmhos
Plate Current	1.1	3.5	ma.
Screen Current	1.3	2.7	ma.
Anode-Grid Current	2	4	ma.
Oscillator-Grid Current	0.25	0.4	ma.
Total Cathode Current	4.6	10.6	ma.

NOTE: The transconductance of the oscillator portion (not oscillating) is 1150 micromhos under the following conditions: plate volts, 250; screen volts, 55; control-grid volts, -2; anode-grid volts, 100; and oscillator-grid volts, -1. ←

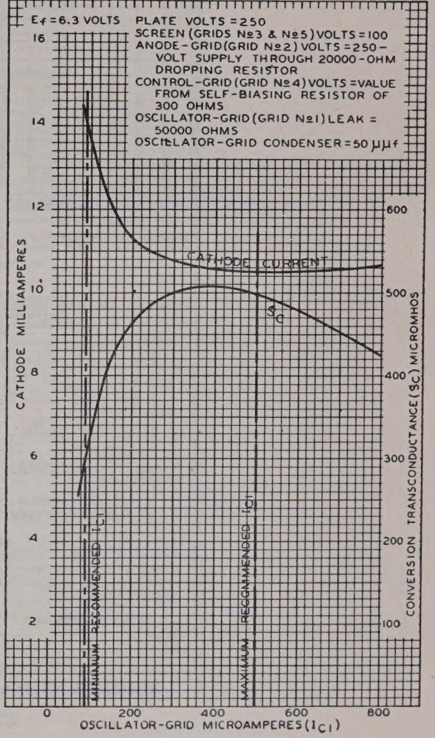
* Anode-grid supply voltages in excess of 200 volts require use of 20000-ohm voltage-dropping resistor by-passed by 0.1 μf condenser.

For Typical Circuit and Coil Design Details, refer to Type 2A7.

← Indicates a change.

6A8

OPERATION CHARACTERISTICS
WITH 50000-OHM OSCILLATOR-GRID LEAK

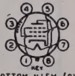


6AG7

VIDEO POWER AMPLIFIER PENTODE

SINGLE-ENDED METAL TYPE

Heater *	Coated Unipotential Cathode	
Voltage	6.3	a-c or d-c volts
Current	0.65	amp.
Direct Interelectrode Capacitances:°		
Grid to Plate		0.06 max. μμf
Input		13 μμf
Output		7.5 μμf
Grid to Screen		5.8 approx. μμf
Grid to Cathode		5.2 approx. μμf
Heater to Cathode		10.7 approx. μμf
Maximum Overall Length		3-1/4"
Maximum Seated Height		2-11/16"
Maximum Diameter		1-5/16"
Bulb		Metal Shell, MT-8
Base		Small Wafer Octal 8-Pin



Pin 1 - Shell-
Pin 2 - Heater
Pin 3 - Interlead Shield
Pin 4 - Grid
Pin 5 - Cathode
Pin 6 - Screen
Pin 7 - Heater
Pin 8 - Plate

BOTTOM VIEW (8Y)

Mounting Position Vertical#

Maximum and Minimum Ratings Are Design-Center Values

AMPLIFIER

Plate Voltage	300 max.	volts
Screen Voltage	300 max.	volts
Grid Voltage	0 min.	volts
Plate Dissipation	9.0 max.	watts ←
Screen Dissipation	1.5 max.	watts ←

Typical Operation and Characteristics - Class A_1 Amplifier:

Plate	300	volts
Screen	150	volts
Grid •	-3	volts
Peak A-F Grid	3	volts
Zero-Sig. Plate Cur.	30	ma.
Max.-Sig. Plate Cur.	30.5	ma.
Zero-Sig. Screen Cur	7	ma.
Max.-Sig. Screen Cur	9	ma.
Plate Res.	0.13	megohm
Transcond.	11000	μmhos
Load Res.	10000	ohms
Total Harmonic Distortion	7	%
Max-Sig. Power Output	3	watts

Typical Operation in 4 Mc Bandwidth Video Voltage Amplifier (Class A_1): ←

	Grid-Leak Bias ▽	Cathode Bias	
Plate-Supply	300	300	volts
Screen	115 □ ▲	125 □□	volts
Grid	0	-2	volts
Grid Resistor	0.25-0.5	-	megohm
Cathode Resistor ##	-	57	ohms
Interlead Shield	Connected to ground		
Grid Signal Swing (peak to peak)	4	4	volts
Zero-Sig. Plate Cur.	45	28	ma.
Zero-Sig. Screen Cur.	13	7	ma.
Load Resistance	3500	3500	ohms
Voltage Output (peak to peak)	135	140	volts

* The heater voltage should not deviate more than 10% from 6.3 volts. In circuits where the cathode is not connected directly to the heater, the potential difference between heater and cathode should be kept as low as possible.

° With shell and interlead shield connected to cathode.

# Horizontal operation permitted if pins #2 and #7 are in a vertical plane.

• When the grid circuit has a resistance not higher than 0.25 megohm, fixed bias may be used; for higher values cathode bias is required. With cathode bias, the grid circuit may have a resistance not to exceed 1.0 megohm.

▽ Intended for use where d-c restoration is accomplished in the grid circuit of the 6AG7.

▲ Zero-signal value.

□ Obtained from supply having good regulation.

□□ Obtained preferably from the 300-volt plate supply through a 25000-ohm series screen resistor.

← Indicates a change.

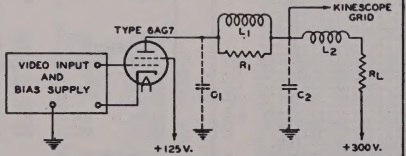
6AG7

VIDEO POWER AMPLIFIER PENTODE

(continued from preceding page)

## By-passed by 250 μf approx.

TYPICAL VIDEO VOLTAGE AMPLIFIER HAVING BANDWIDTH OF 4 MEGACYCLES



C_1 = 9.5 μμf = TUBE OUTPUT CAPACITANCE + SOCKET CAPACITANCE + WIRING CAPACITANCE + COIL CAPACITANCE

C_2 = 19 μμf = KINESCOPE CAPACITANCE + SOCKET CAPACITANCE + WIRING CAPACITANCE + COIL CAPACITANCE

L_1 = 250 μh FILTER INDUCTOR

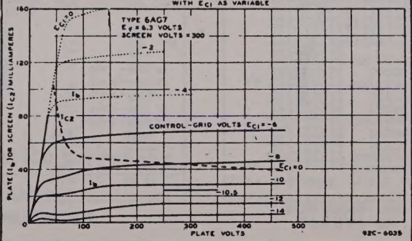
L_2 = 125 μh FILTER INDUCTOR

R_1 = 20000-OHM, NON-REACTIVE RESISTOR

R_L = 3500-OHM, 10-WATT, NON-REACTIVE RESISTOR

The license extended to the purchaser of tubes appears in the License Notice accompanying them. Information contained herein is furnished without assuming any obligations.

AVERAGE PLATE CHARACTERISTICS WITH E_{C1} AS VARIABLE

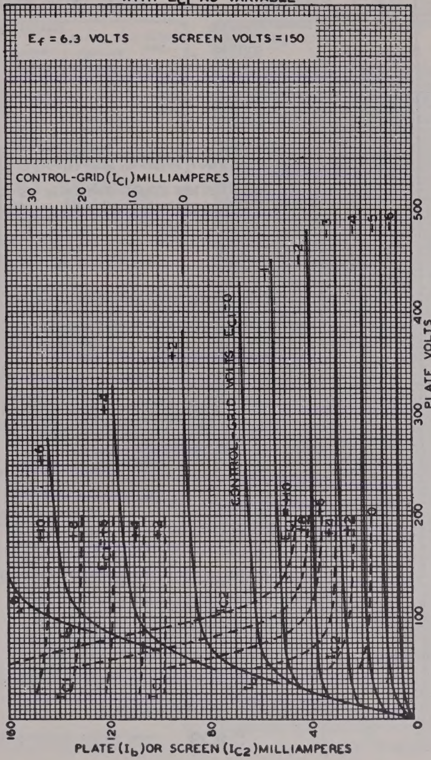


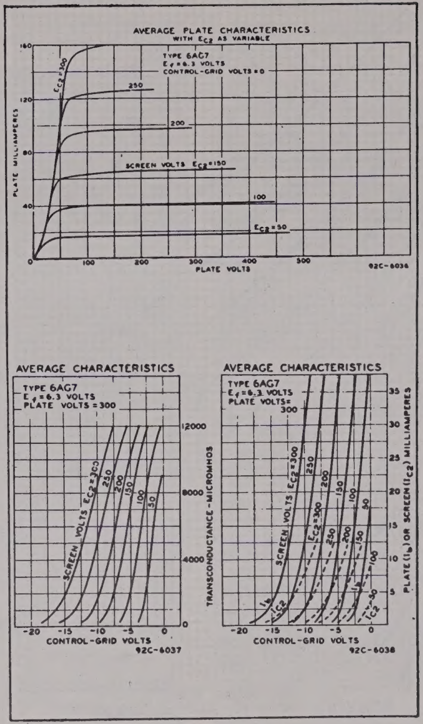
6AG7

VIDEO POWER AMPLIFIER PENTODE

6AG7

AVERAGE PLATE CHARACTERISTICS WITH E_{C1} AS VARIABLE





6C8-G

TWIN-TRIODE AMPLIFIER

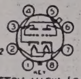
Heater ■	Coated Unipotential Cathodes		
Voltage	6.3	a-c or d-c	volts
Current	0.3		amp.

Direct Interelectrode Capacitances (Approx.):

	Triode Unit T_1		*Triode Unit T_2*		
Grid to Plate	2.6		1.8	μμf	←
Grid to Cathode	2.6		1.3	μμf	
Plate to Cathode	2.0		2.2	μμf	
Grid to Grid		0.1		μμf	
Plate to Plate		2.0		μμf	

Overall Length	4-7/32" to 4-15/32"	
Seated Height	3-21/32" to 3-29/32"	←
Maximum Diameter	1-9/16"	
Bulb	ST-12	
Cap	Skirted Miniature, Style A	
Base	Small Shell Octal 8-Pin	

Pin 1 – No Connection	Pin 6 – Plate (Triode T_1)
Pin 2 – Heater	Pin 7 – Heater
Pin 3 – Plate (Triode T_2)	Pin 8 – Cathode (Triode T_1)
Pin 4 – Cathode (Triode T_2)	Cap – Grid (Triode T_2)
Pin 5 – Grid (Triode T_1)	



BOTTOM VIEW (G-8G)

Mounting Position Any

EACH TRIODE UNIT

Plate Voltage	250 max.	volts	
Grid Voltage	0 min.	volts	←
Plate Dissipation	1.0 max.	watt	←

Characteristics – Class A_1 Amplifier:

Plate	250	volts
Grid	−4.5	volts
Amp. Fact.	36	
Plate Res.	22500	ohms
Transcond.	1600	μmhos
Plate Cur.	3.2	ma.

Typical Operation – Resistance-Coupled Amplifier:

See RESISTANCE-COUPLED AMPLIFIER CHART.

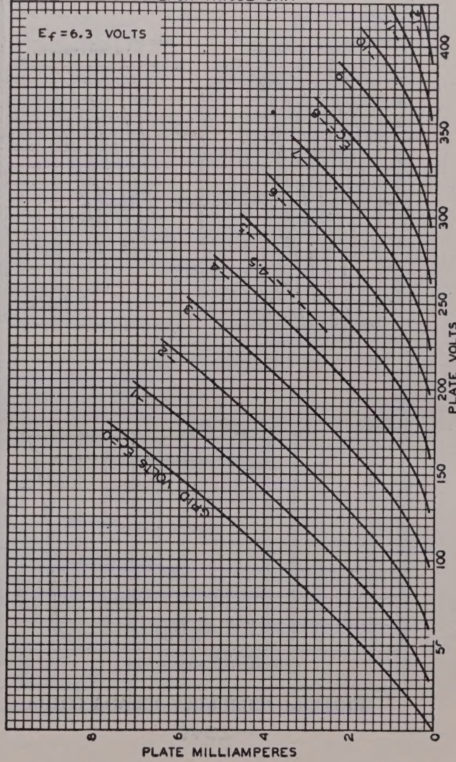
■ In circuits where the cathode is not directly connected to the heater, the potential difference between heater and cathode should be kept as low as possible.

← Indicates a change.

6C8-G

AVERAGE PLATE CHARACTERISTICS

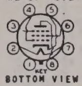
EACH TRIODE UNIT



6SJ7, 6SJ7-GT

TRIPLE-GRID DETECTOR AMPLIFIER

Heater ■	Coated Unipotential Cathode		
Voltage	6.3		a-c or d-c volts
Current	0.3		amp.
Direct Inter. Cap.°	*6SJ7*	*6SJ7-GT*	←
Pentode Conn. Grid to Plate	0.005	0.005	max. μμf
Pentode Conn. Input	6.0	6.3	μμf
Pentode Conn. Output	7.0	10	μμf
Triode Conn.† Grid to Plate	2.8	2.8	μμf
Triode Conn.† Grid to Cathode	3.4	3.4	μμf
Triode Conn.† Plate to Cathode	11	11.0	μμf
Maximum Overall Length	2-5/8"	3-5/16"	
Maximum Seated Height	2-1/16"	2-3/4"	←
Maximum Diameter	1-5/16"	1-5/16"	
Bulb	Metal Shell MT-8	T-9	
Base	Small Wafer Octal 8-Pin	Sm. Wafer Octal 8-Pin, Sleeve	
Basing Designation	8N	GT-8N	



Pin 1 {6SJ7, Shell; 6SJ7-GT, Base Sleeve
Pin 2 – Heater
Pin 3 – Suppressor
Pin 4 – Grid
Pin 5 – Cathode
Pin 6 – Screen
Pin 7 – Heater
Pin 8 – Plate
Mounting Position: Any

Maximum And Minimum Ratings Are Design-Center Values

AMPLIFIER (Pentode Connection)

Plate Voltage	300 max.	volts
Screen Voltage	125 max.	volts
Screen Supply Voltage	300 max.	volts
Grid Voltage	0 min.	volts
Plate Dissipation	2.5 max.	watts
Screen Dissipation	0.3 max.	watt

Typical Operation and Characteristics-Class A_1 Amplifier:

Plate	100	250	volts
Screen	100	100	volts
Grid	-3	-3	volts
Suppressor	Connected to cathode at socket		
Plate Res.	0.7	#	megohm
Transcond.	1575	1650	μmhos
Grid Bias for plate current = 10 μamp.	-8	-8	volts ←
Plate Cur.	2.9	3	ma.
Screen Cur.	0.9	0.8	ma.

AMPLIFIER (Triode Connection)†

Plate Voltage	250 max.	volts
Grid Voltage	0 min.	volts
Plate Dissipation	2.5 max.	watts

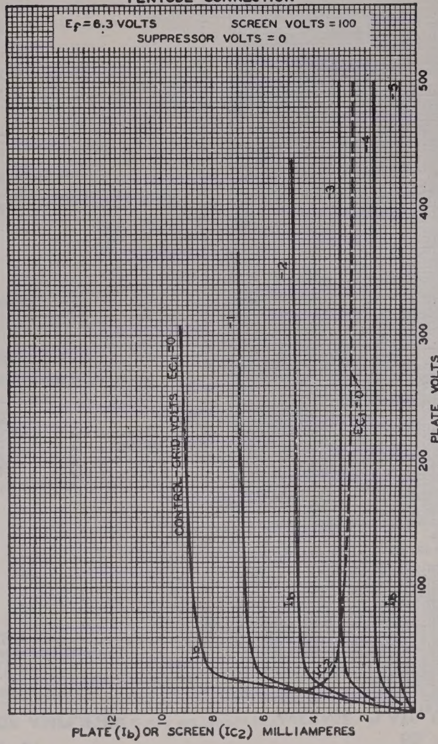
Typical Operation and Characteristics-Class A_1 Amplifier:

Plate	180	250	volts
Grid	-6	-8.5	volts
Amp. Fact.	19	19	
Plate Res.	8250	7600	ohms
Transcond.	2300	2500	μmhos
Plate Cur.	6	9.2	ma.

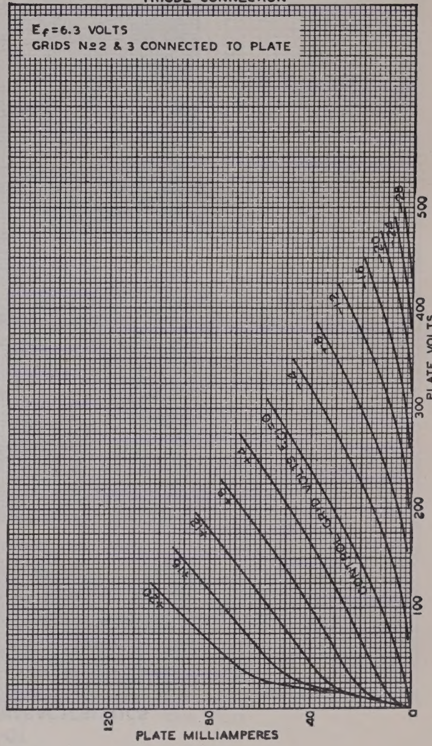
■ In circuits where the cathode is not directly connected to the heater, the potential difference between heater and cathode should be kept as low as possible.
° With shell or external shield connected to cathode.
Greater than 1.0 megohm.
† With screen and suppressor connected to plate.
← Indicates a change.

For additional data, refer to RESISTANCE-COUPLED AMPLIFIER CHART.

6SJ7
AVERAGE PLATE CHARACTERISTICS
PENTODE CONNECTION



6SJ7
AVERAGE PLATE CHARACTERISTICS
TRIODE CONNECTION



6SL7-GT

TWIN-TRIODE AMPLIFIER

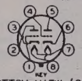
Heater■	Coated Unipotential Cathodes		
Voltage	6.3		a-c or d-c volts
Current	0.3		amp.

Direct Interelectrode Capacitances (Approx.):°

	Triode Unit T_1	*Triode Unit T_2*	
Grid to Plate	2.8	2.8	μμf
Grid to Cathode	3.0	3.4	μμf
Plate to Cathode	3.8	3.2	μμf
Plate to Plate	0.4		μμf
Grid to Grid	0.65		μμf
Grid T_2 to Plate T_1	0.13		μμf

Maximum Overall Length	3-5/16"
Maximum Seated Height	2-3/4"
Maximum Diameter	1-5/16"
Bulb	T-9
Base	Intermediate Shell Octal 8-Pin

Pin 1 - Grid T_2	Pin 5 - Plate T_1
Pin 2 - Plate T_2	Pin 6 - Cathode T_1
Pin 3 - Cathode T_2	Pin 7 - Heater
Pin 4 - Grid T_1	Pin 8 - Heater



Mounting Position Any

BOTTOM VIEW (8BD)

For convenience, one triode unit is identified as T_1; the other as T_2

AMPLIFIER - Each Unit

Plate Voltage	250 max.	volts
Grid Voltage	0 min.	volts
Plate Dissipation	1 max.	watt
Characteristics - Class A_1 Amplifier:		
Plate	250	volts
Grid	−2	volts
Amp. Fact.	70	
Plate Res.	44000	ohms
Transcond.	1600	μmhos
Plate Cur.	2.3	ma.

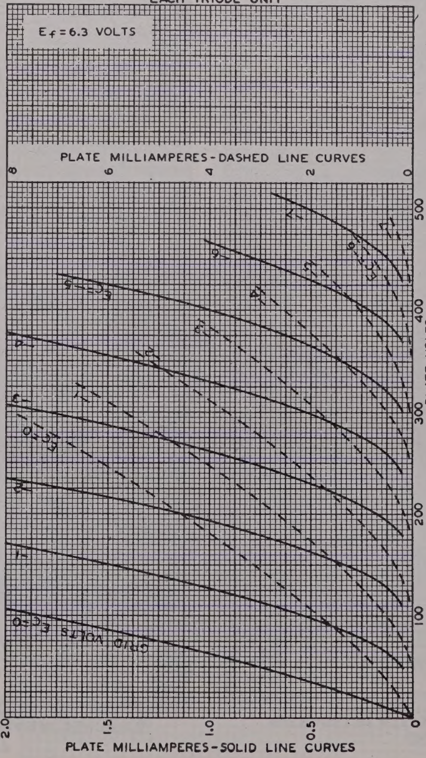
■ In circuits where the cathode is not directly connected to the heater, the potential difference between heater and cathode should be kept as low as possible.

° With close-fitting shield connected to cathode.

6SL7-GT

AVERAGE PLATE CHARACTERISTICS

EACH TRIODE UNIT



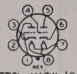
6SN7-GT

TWIN-TRIODE AMPLIFIER

Heater■	Coated Unipotential Cathodes		
Voltage	6.3		a-c or d-c volts
Current	0.6		amp.
Direct Interelectrode Capacitances (Approx.):° ←			
	Triode Unit T_1	*Triode Unit T_2*	
Grid to Plate	3.8	4.0	μμf
Grid to Cathode	3.0	3.0	μμf
Plate to Cathode	0.8	1.2	μμf
Maximum Overall Length			3-5/16"
Maximum Seated Height			2-3/4"
Maximum Diameter			1-5/16"
Bulb			T-9
Base			Intermediate Shell Octal 8-Pin

Pin 1 - Grid T_2	Pin 5 - Plate T_1
Pin 2 - Plate T_2	Pin 6 - Cathode T_1
Pin 3 - Cathode T_2	Pin 7 - Heater
Pin 4 - Grid T_1	Pin 8 - Heater

Mounting Position Any



BOTTOM VIEW (8BD)

For convenience, one triode unit is identified as T_1; the other as T_2.

Maximum And Minimum Ratings Are Design-Center Values

AMPLIFIER - Each Unit

Plate Voltage		300 max.	volts
Grid Voltage		0 min.	volts
Plate Dissipation		2.5 max.	watts
Characteristics — Class A_1 Amplifier:			
Plate	90	250	volts
Grid #	0	-8	volts
Amp. Fact.	20	20	
Plate Res.	6700	7700	ohms
Transcond.	3000	2600	μmhos
Plate Cur.	10	9	ma.

Typical Operation with Resistance Coupling:
Same as for Type 6F8-G in RESISTANCE-COUPLED AMPLIFIER CHART.

■ In circuits where the cathode is not directly connected to the heater, the potential difference between heater and cathode should be kept as low as possible.

° With shield connected to cathode.

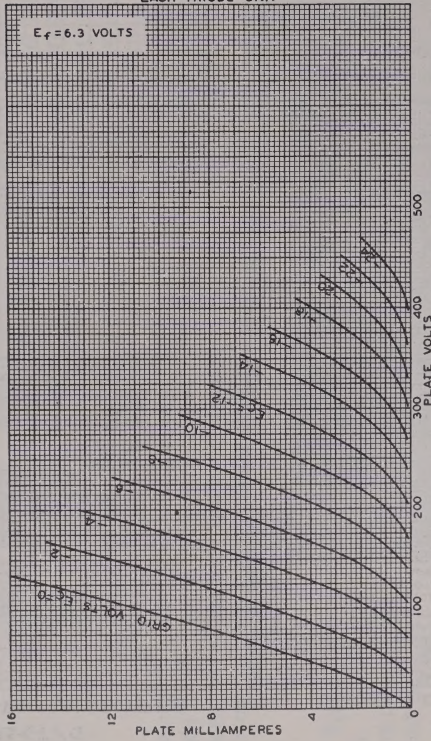
The d-c resistance in the grid circuit should not exceed 1.0 megohm under maximum rated conditions per unit.

The curves under Type 6J5 also apply to each unit of the 6SN7-GT.

← Indicates a change.

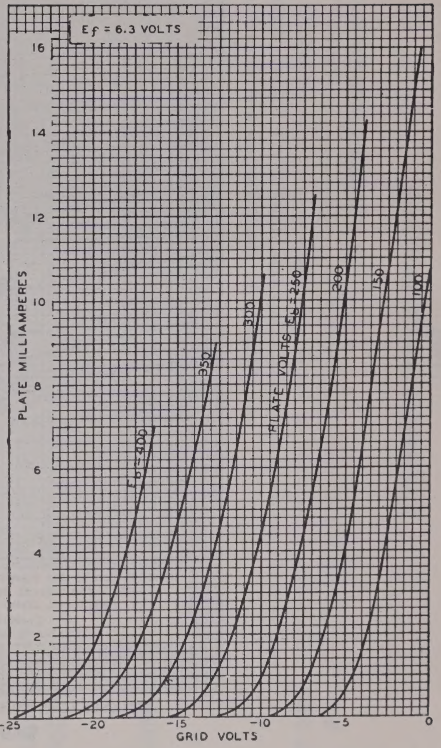
6SN7-GT

AVERAGE PLATE CHARACTERISTICS
EACH TRIODE UNIT



6J5

AVERAGE CHARACTERISTICS



6X5, 6X5-GT/G

FULL-WAVE HIGH-VACUUM RECTIFIER

Heater	Coated Unipotential Cathode	
Voltage	6.3	a-c or d-c volts
Current	0.6	amp.

	6X5	*6X5-GT/G*
Maximum Overall Length	3-1/4"	3-5/16"
Maximum Seated Height	2-11/16"	2-3/4"
Maximum Diameter	1-5/16"	1-5/16"
Bulb	Metal Shell, MT-8	T-9
Base	Small Wafer Octal 6-Pin	Intermed. Sh. Octal 6-Pin
Basing Designation	6S	G-6S

Pin 1 {6X5, Shell; 6X5-GT/G, No Con.

Pin 2 - Heater

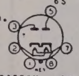
Pin 3 - Plate #2

Pin 5 - Plate #1

Pin 7 - Heater

Pin 8 - Cathode

Mounting Position {6X5: Vertical◇; 6X5-GT/G: Any



BOTTOM VIEW

Maximum Ratings Are Design-Center Values

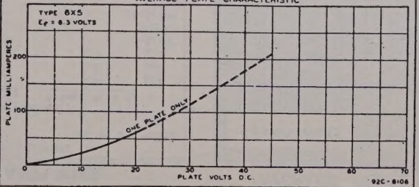
FULL-WAVE RECTIFIER

Peak Inverse Plate Voltage	1250 max. volts
Peak Plate Current per Plate	210 max. ma.
D-C Output Current:	
With condenser input to filter	70 max. ma.
With choke input to filter	70● max. ma.
D-C Heater-Cathode Potential	450 max. volts

Typical Operation:	*Condenser-Input Filter*	*Choke-Input Filter*	
A-C Plate-to-Plate Supply Voltage (RMS)	650	900	volts
Filter Input Condenser	4	-	µf
Min. Total Effect. Plate-Supply Imped. per Plate	150	-	ohms
Filter Input Choke	-	8	henries
D-C Output Current	70	70	ma.
D-C Voltage (At input to filter):*			
At half-load current (35 ma.)	405	385	volts
At full-load current (70 ma.)	370	380	volts
Difference (Voltage Regulation)	35	5	volts
Percentage Regulation	8.5	1.3	%

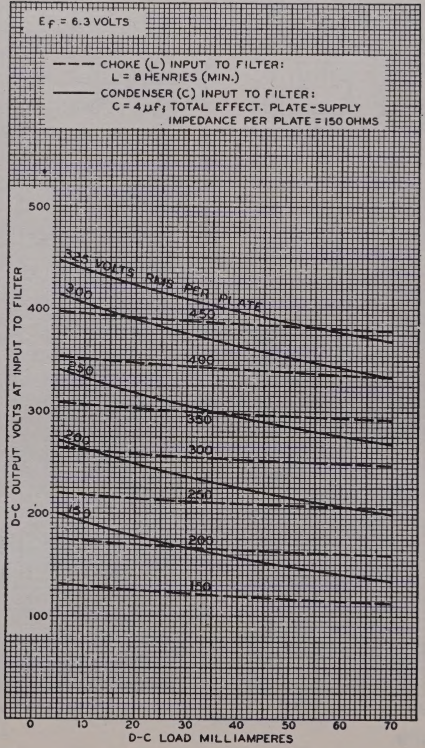
◇ Horizontal operation permitted if pins 3 & 5 are in a horizontal plane.
● For choke not less than 8 henries.
* Approximate values.

AVERAGE PLATE CHARACTERISTIC



6X5

OPERATION CHARACTERISTICS



450TL
GENERAL CHARACTERISTICS

Electrical

Filament: Thoriated tungsten	
Voltage	7.5 volts
Current	12.0 amperes
Amplification Factor (Average)	19
Direct Interelectrode Capacitances (Average)	
Grid-Plate	5.0 μμf
Grid-Filament	6.6 μμf
Plate-Filament	0.9 μμf
Transconductance ($I_b=500$ ma., $E_b=4000$, $e_c=-170$)	6650 μmhos
Frequency for Maximum Ratings	40 mc

Mechanical

Base	4 pin, No. 5002B
Basing	RMA type 4AQ
Maximum Overall Dimensions:	
Length	12.625 inches
Diameter	5.125 inches
Net Weight	1 pound
Shipping Weight (Average)	4½ pounds

Class B
Audio Frequency Power Amplifier and Modulator

	Typical Operation—2 Tubes			Max. Rating
D-C Plate Voltage	3000	4000	5000	5000 volts
Max.-Signal D-C Plate Current, per tube*	•	•	•	500 ma.
Plate Dissipation, per tube*	•	•	•	450 watts
D-C Grid Voltage (approx.)	–140	–200	–265	volts
Peak A-F Grid Input Voltage	780	880	950	volts
Zero-Signal D-C Plate Current	270	200	160	ma.
Max.-Signal D-C Plate Current	860	750	720	ma.
Max.-Signal Driving Power (approx.)	33	30	30	watts
Effective Load, Plate-to-Plate	7660	12100	16800	ohms
Max.-Signal Plate Power Output	1670	2100	2700	watts

*Averaged over any sinusoidal audio frequency cycle.

Class C *Telegraphy
(Key down conditions without modulation)

Radio Frequency Power Amplifier and Oscillator

	Typical Operation—1 Tube			Max. Rating
D-C Plate Voltage	3000	4000	5000	6000 volts
D-C Plate Current	450	450	450	500 ma.
D-C Grid Current	62	59	57	75 ma.
D-C Grid Voltage	–340	–400	–440	volts
Plate Power Output	1040	1425	1820	watts
Plate Input	1350	1800	2250	watts
Plate Dissipation	310	375	430	450 watts
Peak R.F. Grid Input Voltage, (approx.)	670	724	760	volts
Driving Power, (approx.)	38	38	39	watts

*The above figures show actual measured tube performance, and do not allow for circuit losses.

450TL

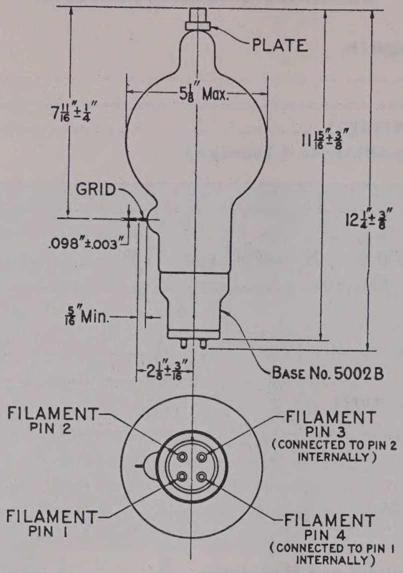
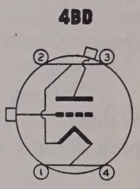
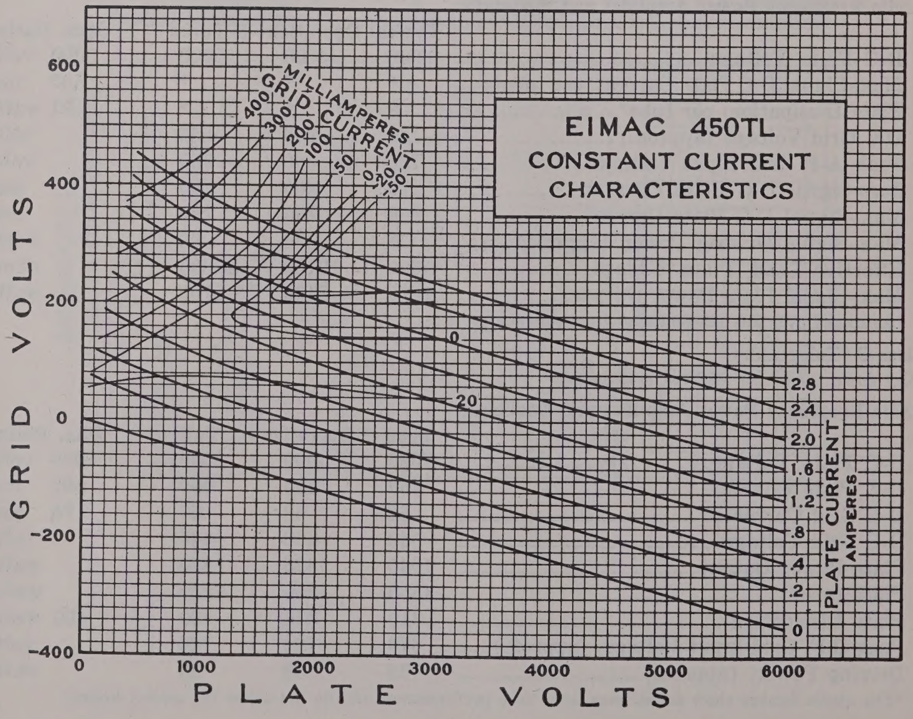


PLATE
5⅛" Max.
7 11/16" ± 1/4"
11 15/16" ± 3/8"
GRID
12 1/4" ± 3/8"
.098" ±.003"
5/16" Min.
2 1/8" ± 3/16"
Base No. 5002B
FILAMENT PIN 2
FILAMENT PIN 3 (CONNECTED TO PIN 2 INTERNALLY)
FILAMENT PIN 1
FILAMENT PIN 4 (CONNECTED TO PIN 1 INTERNALLY)


4BD
2
3
1
4


EIMAC 450TL
CONSTANT CURRENT CHARACTERISTICS
GRID CURRENT MILLIAMPERES
400
300
200
100
50
0
20
50
0
20
GRID VOLTS
600
400
200
0
-200
-400
PLATE VOLTS
0
1000
2000
3000
4000
5000
6000
PLATE CURRENT AMPERES
2.8
2.4
2.0
1.6
1.2
.8
.4
.2
0

750TL
GENERAL CHARACTERISTICS

Electrical

Filament: Thoriated tungsten

Voltage	7.5 volts
Current	21.0 amperes
Amplification Factor (Average)	15
Direct Interelectrode Capacitances (Average)	
Grid-Plate	5.8 µµf
Grid-Filament	8.5 µµf
Plate-Filament	1.2 µµf
Transconductance ($I_b=1.0$ amp., $E_b=5000$, $e_c=-100$)	3500 µmhos
Frequency for Maximum Ratings	40 mc

Mechanical

Base	Special 4 pin, (Fits Johnson No. 214 Socket, or equal) No. 5003B
Basing	RMA type 4BD
Maximum Overall Dimensions:	
Length	17.0 inches
Diameter	7.125 inches
Net Weight	2.75 pounds
Shipping Weight (Average)	8.0 pounds

Audio Frequency Power Amplifier and Modulator
Class B

	Typical Operation—2 Tubes			Max. Rating
D-C Plate Voltage	4000	5000	6000	10000 volts
Max.-Signal D-C Plate Current, per tube*	•	•	•	1000 ma.
Plate Dissipation, per tube*	•	•	•	750 watts
D-C Grid Voltage (approx.)	–200	–285	–350	volts
Peak A-F Grid Input Voltage	910	1060	1200	volts
Zero-Signal D-C Plate Current	.250	.200	.166	amps.
Max.-Signal D-C Plate Current	.950	.860	.834	amps.
Max.-Signal Driving Power (approx.)	24	23	30	watts
Effective Load, Plate-to-Plate	8270	12300	16300	ohms
Max.-Signal Plate Power Output	2300	2800	3500	watts

*Averaged over any sinusoidal audio frequency cycle.

Radio Frequency Power Amplifier and Oscillator
Class C *Telegraphy
(Key down conditions without modulation)

	Typical Operation—1 Tube				Max. Rating
D-C Plate Voltage	3000	4000	5000	6000	10000 volts
D-C Plate Current	713	625	600	625	1000 ma.
D-C Grid Current	95	69	67	78	125 ma.
D-C Grid Voltage	–350	–450	–550	–700	volts
Plate Power Output	1390	1750	2250	3000	watts
Plate Input	2140	2500	3000	3750	watts
Plate Dissipation	750	750	750	750	750 watts
Peak R.F. Grid Input Voltage, (approx.)	860	900	1000	1120	volts
Driving Power, (approx.)	74	53	61	93	watts

*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

750TL

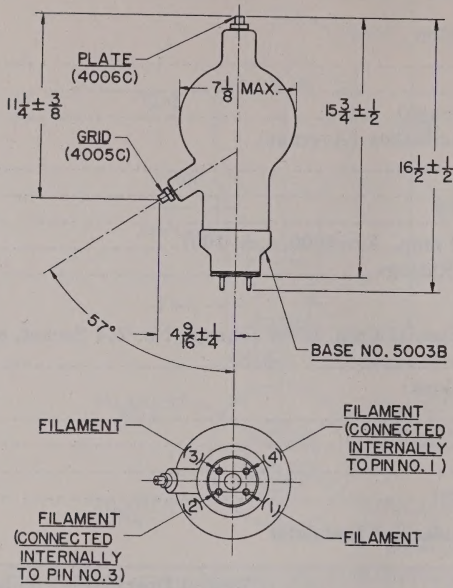
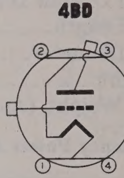
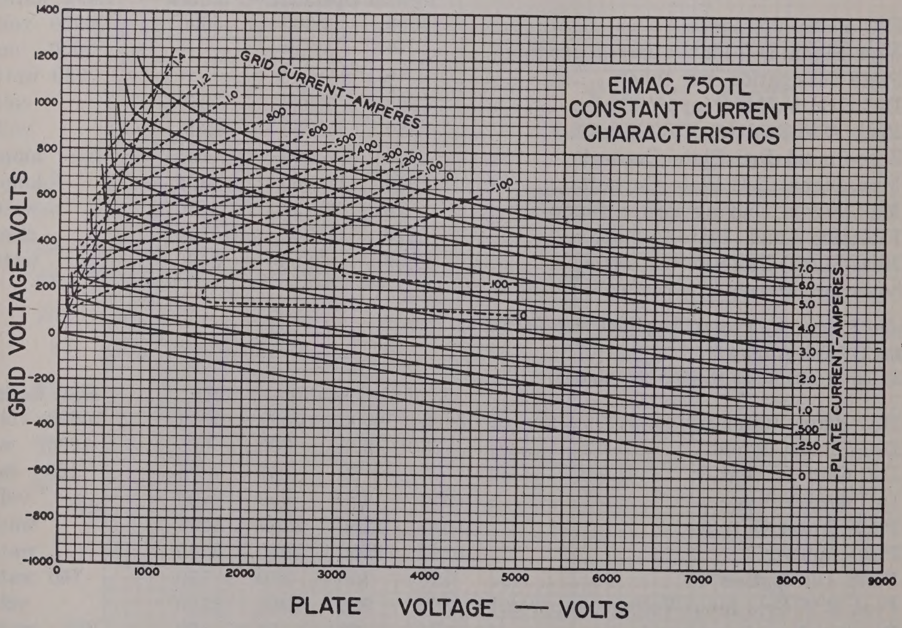


PLATE
(4006C)
11 1/4 ± 3/8
7 1/8 MAX.
15 3/4 ± 1/2
16 1/2 ± 1/2
GRID
(4005C)
57°
4 9/16 ± 1/4
BASE NO. 5003B
FILAMENT
(3)
(4)
FILAMENT
(CONNECTED
INTERNALLY
TO PIN NO. 1)
(2)
(1)
FILAMENT
(CONNECTED
INTERNALLY
TO PIN NO. 3)
FILAMENT


4BD
2
3
1
4


EIMAC 750TL
CONSTANT CURRENT
CHARACTERISTICS
GRID VOLTAGE—VOLTS
1400
1200
1000
800
600
400
200
0
-200
-400
-600
-800
-1000
PLATE VOLTAGE — VOLTS
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
GRID CURRENT–AMPERES
1.4
1.2
1.0
.800
.600
.500
.400
.300
.200
.100
0
.100
.100
0
PLATE CURRENT–AMPERES
7.0
6.0
5.0
4.0
3.0
2.0
1.0
.500
.250
0

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TRANSMITTING BEAM POWER AMPLIFIER

Heater●	Coated Unipotential Cathode		
Voltage	6.3	a-c or d-c volts	
Current	0.9	amp.	
Transconductance for plate cur. of 72 ma.	6000 approx.	μmhos	
Grid-Screen Mu-Factor	8		←
Direct Interelectrode Capacitances:			
Grid to Plate (With external shielding)	0.2 max.	μμf	
Input	11	μμf	
Output	7	μμf	
Maximum Overall Length	5-3/4"		
Maximum Diameter	2-1/16"		
Bulb	ST-16		
Cap	Small Metal		
Base	Medium 5-Pin, MICANOL△		

MAXIMUM CCS and ICAS RATINGS
with TYPICAL OPERATING CONDITIONS

CCS = Continuous Commercial Service
ICAS = Intermittent Commercial and Amateur Service

A-F POWER AMPLIFIER & MODULATOR – Class AB_2#

	CCS	ICAS	
D-C Plate Voltage	600 max.	750 max.	volts
D-C Screen Voltage (Grid #2)	300 max.	300 max.	volts
Max.-Signal D-C Plate Cur.*	120 max.	120 max.	ma.
Max.-Signal Plate Input*	60 max.	90 max.	watts
Screen Input*	3.5 max.	3.5 max.	watts
Plate Dissipation*	25 max.	30 max.	watts

Typical Operation:
Unless otherwise specified, values are for 2 tubes

	CCS			ICAS		
D-C Plate Voltage	400	500	600	750	volts	
D-C Screen Voltage	300	300	300	300	volts	
D-C Grid Voltage (Fixed bias, Grid #1)	-25	-25	-30	-32	volts	
Peak A-F Grid-to-Grid Voltage	78	78	78	92	volts	←→
Zero-Sig. D-C Plate Cur.	100	100	60	60	ma.	→
Max.-Sig. D-C Plate Cur.	240	240	200	240	ma.	←→
Zero-Sig. D-C Screen Cur.	5	5	5	5	ma.	←→
Max.-Sig. D-C Screen Cur.	10	10	10	10	ma.	
Load Resistance (Per tube)	800	1060	1600	1740	ohms	→ ←
Effective Load Resistance (Plate to plate)	3200	4240	6400	6950	ohms	←
Peak Grid Input Power°	0.2	0.2	0.1	0.2	approx. watt	←
Max.-Sig. Power Output**	55	75	80	120	approx. watts	←

● In circuits where the cathode is not directly connected to the heater, the potential difference between them should not exceed 100 volts. Under the maximum plate and screen dissipation conditions, the heater voltage should not fluctuate so that it exceeds 7.0 volts.

* Averaged over any audio-frequency cycle of sine-wave form.

# Subscript 2 indicates that grid current flows during some part of input cycle.

△ Registered trademark.

←Indicates a change.

°, **: See next page.

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TRANSMITTING BEAM POWER AMPLIFIER

(continued from preceding page)

R-F POWER AMPLIFIER – Class B Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

	CCS	ICAS	
D-C Plate Voltage	600 max.	750 max.	volts
D-C Screen Voltage (Grid #2)	300 max.	300 max.	volts
D-C Plate Current	80 max.	90 max.	ma.
Plate Input	37.5 max.	45 max.	watts
Screen Input	2.5 max.	2.5 max.	watts
Plate Dissipation	25 max.	30 max.	watts

Typical Operation:

	CCS			ICAS	
D-C Plate Voltage	400	500	600	750	volts
D-C Screen Voltage	250	250	250	300	volts
D-C Grid Volt. (Grid #1)†	-25	-25	-25	-35	volts
Peak R-F Grid Voltage	30	30	20	27	volts
D-C Plate Current	75	75	62.5	60	ma.
D-C Screen Current	4	4	3	3	ma.
D-C Grid Cur. (Approx.)	0	0	0	0	ma.
Driving Power (Approx.)°°	0.25	0.25	0.2	0.12	watt
Power Output (Approx.)	9	12.5	12.5	15	watts

°° At crest of a-f cycle with modulation factor of 1.0.

PLATE-MODULATED R-F POWER AMPLIFIER – Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

	CCS	ICAS	
D-C Plate Voltage	475 max.	600 max.	volts
D-C Screen Voltage (Grid #2)	300 max.	300 max.	volts
D-C Grid Voltage (Grid #1)	-200 max.	-200 max.	volts
D-C Plate Current	83 max.	100 max.	ma.
D-C Grid Current	5 max.	5 max.	ma.
Plate Input	40 max.	60 max.	watts
Screen Input	2.5 max.	2.5 max.	watts
Plate Dissipation	16.5 max.	25 max.	watts

Typical Operation:

	CCS			ICAS	
D-C Plate Voltage	325	400	475	600	volts
D-C Screen Voltage ◊	225	225	225	275	volts
	20000	30000	50000	50000	ohms
D-C Grid Voltage ▲†	-75	-80	-85	-90	volts
	25000	22800	21300	22500	ohms
Peak R-F Grid Voltage	90	95	110	115	volts
D-C Plate Current	80	80	83	100	ma.
D-C Screen Current	5	5.75	5	6.5	ma.

° Driver stage should be capable of supplying the grids of the class AB_2 stage with the specified peak values at low distortion. The effective resistance per grid circuit of the class AB_2 stage should be kept below 500 ohms and the effective impedance at the highest desired response frequency should not exceed 700 ohms.

◊ Obtained preferably from *modulated* fixed supply, or from *modulated* plate supply through resistor of value shown.

▲ May be obtained from grid resistor (25000, 22800, 21300, 22500) although combination of either grid resistor and cathode resistor or grid resistor and fixed supply is recommended.

** With zero-impedance driver and perfect regulation, plate-circuit distortion does not exceed 2%. In practice, plate-voltage regulation, screen-voltage regulation, and grid-bias regulation, should not be greater than 5%, 5%, and 3%, respectively.

† See end of tabulation.

← Indicates a change.

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TRANSMITTING BEAM POWER AMPLIFIER

(continued from preceding page)

	CCS			ICAS		
D-C Grid Current (Approx.)	3	3.5	4	4	ma.	←
Driving Power (Approx.)	0.25	0.3	0.4	0.4	watt	←
Power Output (Approx.)	17.5	22.5	27.5	42.5	watts	←

R-F POWER AMPLIFIER & OSCILLATOR – Class C Telegraphy

Key-down conditions per tube without modulation ##

	CCS	ICAS	
D-C Plate Voltage	600 max.	750 max.	volts
D-C Screen Voltage (Grid #2)	300 max.	300 max.	volts
D-C Grid Voltage (Grid #1)	-200 max.	-200 max.	volts
D-C Plate Current	100 max.	100 max.	ma.
D-C Grid Current	5 max.	5 max.	ma.
Plate Input	60 max.	75 max.	watts
Screen Input	3.5 max.	3.5 max.	watts
Plate Dissipation	25 max.	30 max.	watts

Typical Operation:

	CCS			ICAS		
D-C Plate Voltage	400	500	600	750	volts	
D-C Screen Voltage §	250	250	250	250	volts	
	20000	42000	50000	85000	ohms	←
D-C Grid Voltage□ †	-45	-45	-45	-45	volts	←
	12800	12800	12800	12800	ohms	←
	410	410	410	410	ohms	←
Peak R-F Grid Voltage	65	65	65	65	volts	←
D-C Plate Current	100	100	100	100	ma.	←
D-C Screen Current	7.5	6	7	6	ma.	←
D-C Grid Cur. (Approx.)	3.5	3.5	3.5	3.5	ma.	←
Driving Power (Approx.)	0.2	0.2	0.2	0.2	watt	←
Power Output (Approx.)	25	30	40	50	watts	←

† The total effective grid-circuit resistance should not exceed 25000 ohms.

## Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

§ Obtained from separate source, from a potentiometer, or from plate supply through a series resistor of value shown.

□ Obtained from fixed supply, by grid resistor (12800), by cathode resistor (410), or by combination methods.

Data on operating frequencies for the 807 are given on the sheet TRANS. TUBE RATINGS vs FREQUENCY.

←Indicates a change.

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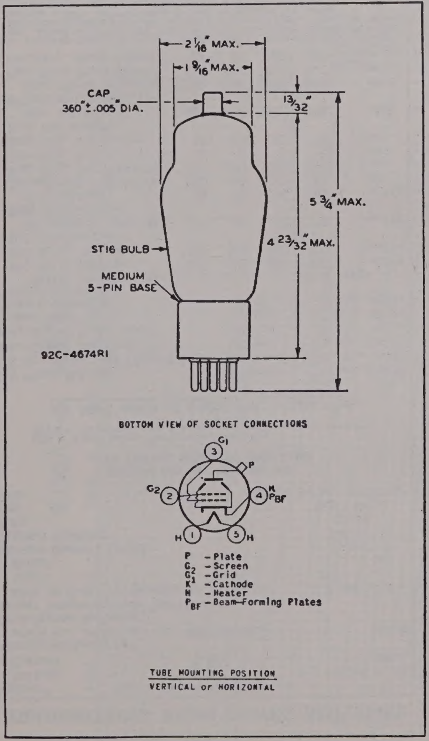
TRANSMITTING BEAM POWER AMPLIFIER



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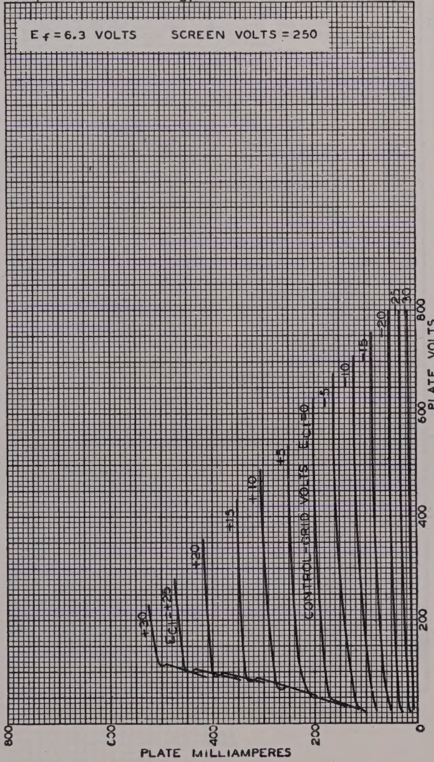
AVERAGE PLATE CHARACTERISTICS WITH E_{C1} AS VARIABLE



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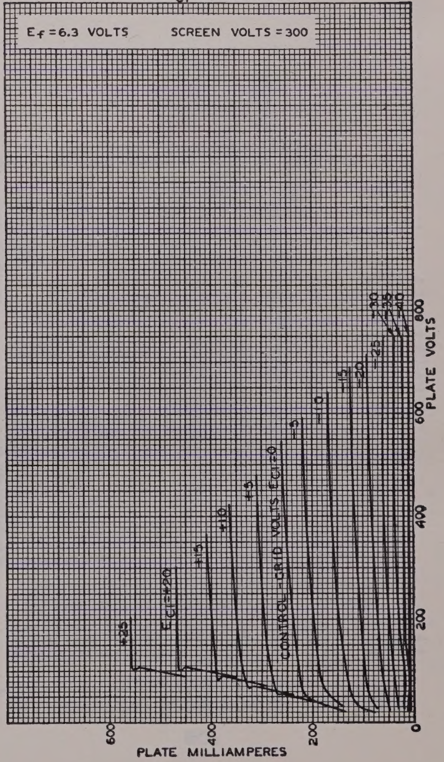
AVERAGE PLATE CHARACTERISTICS WITH E_{C1} AS VARIABLE



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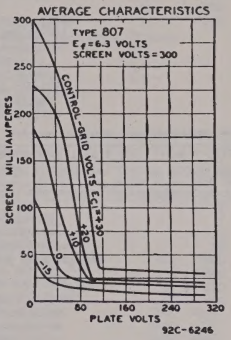
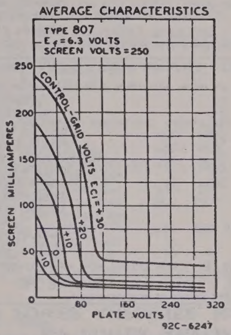
TRANSMITTING BEAM POWER AMPLIFIER





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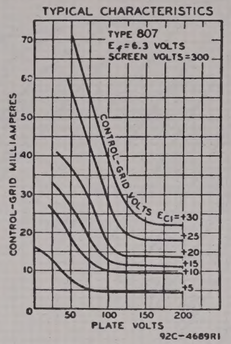
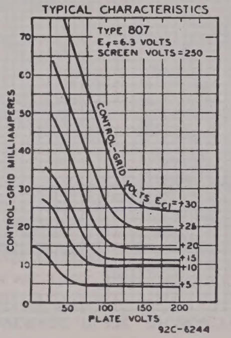
TRANSMITTING BEAM POWER AMPLIFIER





801-A
R-F POWER AMPLIFIER, A-F POWER AMPLIFIER, MODULATOR

(continued from preceding page)

R-F POWER AMPLIFIER – Class B Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

D-C Plate Voltage		600 max.	volts
D-C Plate Current		50 max.	ma.
Plate Input		30 max.	watts
Plate Dissipation		20 max.	watts
Typical Operation:			
D-C Plate Voltage	500	600	volts
D-C Grid Voltage Δ	-60	-75	volts
Peak R-F Grid Voltage	85	90	volts
D-C Plate Current	45	45	ma.
D-C Grid Current**	0.2	0.2	approx.ma.
Driving Power** ○	2.2	2.3	approx.watts
Power Output	6	7.5	approx.watts

○ At crest of a-f cycle with modulation factor of 1.0

PLATE-MODULATED R-F POWER AMPLIFIER – Class C Telephony

Carrier conditions per tube for use with a max. modulation fact of 1.0

D-C Plate Voltage		500 max.	volts
D-C Grid Voltage		-200 max.	volts
D-C Plate Current		60 max.	ma.
D-C Grid Current		15 max.	ma.
Plate Input		30 max.	watts
Plate Dissipation		13.5 max.	watts
Typical Operation:			
D-C Plate Voltage	400	500	volts
D-C Grid Voltage▲Δ	-150 10000	-190 12700	volts ohms
Peak R-F Grid Voltage	260	300	volts
D-C Plate Current	55	55	ma.
D-C Grid Current**	15	15	approx.ma.
Driving Power**	4	4.5	approx.watts
Power Output	14	18	approx.watts

▲ Obtained by grid resistor of value shown, or by combination of grid resistor with either fixed supply or suitably by-passed cathode resistor.

R-F POWER AMPLIFIER & OSCILLATOR – Class C Telegraphy

Key-down conditions per tube without modulation #

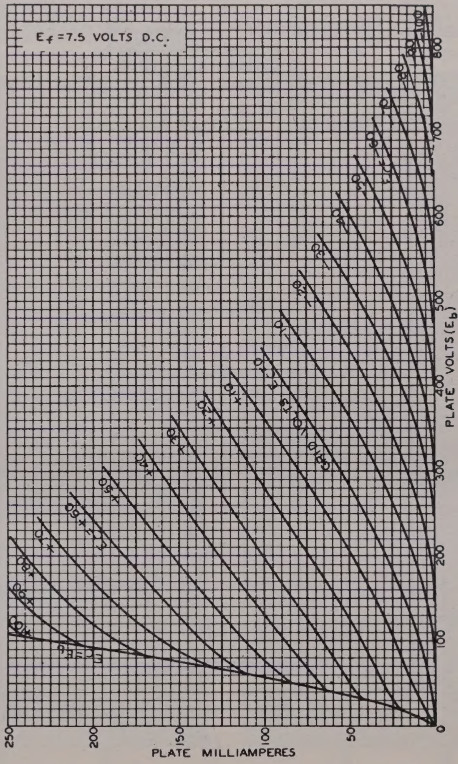
D-C Plate Voltage		600 max.	volts
D-C Grid Voltage		-200 max.	volts
D-C Plate Current		70 max.	ma.
D-C Grid Current		15 max.	ma.
Plate Input		42 max.	watts
Plate Dissipation		20 max.	watts
Typical Operation:			
D-C Plate Voltage	500	600	volts
→ D-C Grid Voltage▽Δ	-125 8300 1560	-150 10000 1875	volts ohms ohms
Peak R-F Grid Voltage	235	260	volts

**, #, ▽, Δ: See next page.

← Indicates a change.

801-A

AVERAGE PLATE CHARACTERISTICS



801-A/801
R-F POWER AMPLIFIER,
A-F POWER AMPLIFIER, MODULATOR

Filament	Thoriated tungsten	
Voltage	7.5	a-c or d-c volts
Current	1.25	amp.
Amplification Factor	8	
Direct Interelectrode Capacitances:		
Grid to Plate	6.0	μμf
Grid to Filament	4.5	μμf
Filament to Plate	1.5	μμf
Maximum Overall Length		5-3/8"
Maximum Diameter		2-1/16"
Bulb		ST-16
Base		Medium 4-Pin "MICANOL", Bayonet ←
RCA Socket		Type UR-542-A

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

A-F POWER AMPLIFIER & MODULATOR - Class A_1

D-C Plate Voltage				600 max.	volts
Plate Dissipation				20 max.	watts
Typical Operation:					
D-C Plate Voltage	425	500	600		volts
D-C Grid Voltage □Δ	-40	-45	-55		volts
Peak A-F Grid Voltage	35	40	50		volts
D-C Plate Current	18	24	30		ma.
Plate Resistance	5000	4600	4300		ohms
Transconductance	1600	1725	1840		μmhos
Load Resistance	10200	8000	7800		ohms
U.P.O. (5% second harmonic)	1.6	2.3	3.8		watts

□ The d-c resistance in the grid circuit should not exceed 0.5 megohm with cathode bias, or 0.1 megohm with fixed bias.

A-F POWER AMPLIFIER & MODULATOR - Class B

D-C Plate Voltage				600 max.	volts
Max.-Signal D-C Plate Current*				70 max.	ma.
Max.-Signal Plate Input*				42 max.	watts
Plate Dissipation*				20 max.	watts
Typical Operation:					
Unless otherwise specified, values are for 2 tubes					
D-C Plate Voltage	400	500	600		volts
D-C Grid Voltage Δ	-50	-60	-75		volts
Peak A-F Grid-to-Grid Voltage	270	290	320		volts
Zero-Signal D-C Plate Cur.	8	8	8		ma.
Max.-Signal D-C Plate Cur.	130	130	130		ma.
Load Resistance (per tube)	1500	2000	2500		ohms
Effective Load Resistance (plate to plate)	6000	8000	10000		ohms
Max.-Signal Driving Power	3	3	3		approx.watts
Max.-Signal Power Output	27	36	45		approx.watts

* Averaged over any audio-frequency cycle of sine-wave form.
Δ With a-c filament supply.

← Indicates a change.

801-A
R-F POWER AMPLIFIER,
A-F POWER AMPLIFIER, MODULATOR

(continued from preceding page)

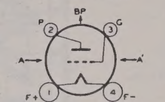
D-C Plate Current	65	65	ma.
D-C Grid Current**	15	15	approx.ma.
Driving Power**	3.5	4	approx.watts
Power Output	20	25	approx.watts

▽ Obtained from fixed supply, by grid resistor (8300, 10000), or by cathode resistor (1560, 1875). When the 801-A is used in the final amplifier or a preceding stage of a transmitter designed for break-in operation and oscillator keying, a small amount of fixed bias must be used to maintain the plate current at a safe value. With plate voltage of 600 volts, a fixed bias of at least 50 volts should be used.
** Subject to wide variations as explained on sheet TRANS. TUBE RATINGS.
# Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions. ←
Δ With a-c filament supply.

For use of the 801 at the higher frequencies, refer to sheet TRANS. TUBE RATINGS vs FREQUENCY.

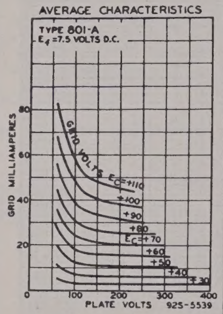
For OUTLINE DIMENSIONS, refer to sheet OUTLINES OF RECEIVING TUBES, drawing of ST-16 bulb with 4-pin base.

BOTTOM VIEW OF SOCKET CONNECTIONS



AA'=PLANE OF ELECTRODES

TUBE MOUNTING POSITION
VERTICAL: Base down.
HORIZONTAL: Plane of plate vertical (on edge).



811

TRANSMITTING TRIODE

(continued from preceding page)

	CCS	ICAS	
D-C Grid Voltage #	0	-6	volts
Peak R-F Grid Voltage	26	35	volts
D-C Plate Current	48	50	ma.
D-C Grid Current**	6 approx.	6 approx.	ma.
Driving Power** ○	1 approx.	1.5 approx.	watts
Power Output	20 approx.	25 approx.	watts

○ At crest of a-f cycle with modulation factor of 1.0.

# Grid voltages are given for either a-c or d-c filament operation. When a.c. is used, the circuit returns are made to the midpoint of the filament circuit. When d.c. is used, the returns are made to the negative filament terminal.

PLATE-MODULATED R-F POWER AMPLIFIER - Class C Telephony

Carrier conditions per tube for use with a max. modulation fact. of 1.0

	CCS	ICAS	
D-C Plate Voltage	1000 max.	1250 max.	volts
D-C Grid Voltage	-200 max.	-200 max.	volts
D-C Plate Current	105 max.	125 max.	ma.
D-C Grid Current	50 max.	50 max.	ma.
Plate Input	105 max.	155 max.	watts
Plate Dissipation	27 max.	40 max.	watts
Typical Operation:			
D-C Plate Voltage	1000	1250	volts
D-C Grid Voltage □	-100 2000	-125 2500	volts ohms
Peak R-F Grid Voltage	195	230	volts
D-C Plate Current	105	125	ma.
D-C Grid Current**	50 approx.	50 approx.	ma.
Driving Power**	9 approx.	11 approx.	watts
Power Output	82 approx.	120 approx.	watts

□ Obtained preferably from grid leak of value shown, or combination of grid leak with either fixed supply or suitably by-passed cathode resistor.

R-F POWER AMPLIFIER & OSCILLATOR - Class C Telegraphy

Key-down conditions per tube without modulation ##

	CCS	ICAS	
D-C Plate Voltage	1250 max.	1500 max.	volts
D-C Grid Voltage	-200 max.	-200 max.	volts
D-C Plate Current	125 max.	150 max.	ma.
D-C Grid Current	50 max.	50 max.	ma.
Plate Input	155 max.	225 max.	watts
Plate Dissipation	40 max.	55 max.	watts
Typical Operation:			
D-C Plate Voltage	1250	1250	volts
D-C Grid Voltage ‡	-87.5 2500 550	-113 3200 610	volts ohms ohms

## Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

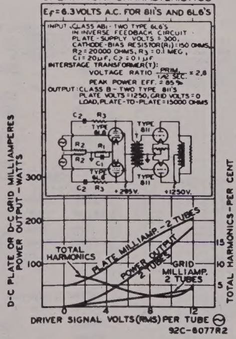
‡ Obtained from fixed supply, or grid resistor (2500, 3200), or by cathode resistor (550, 610).

** See next page.

811

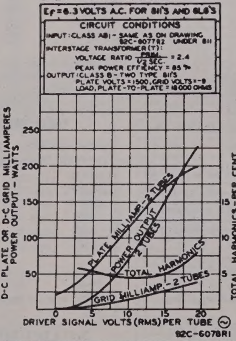
TRANSMITTING TRIODE

OPERATION CHARACTERISTICS



92C-6077R2

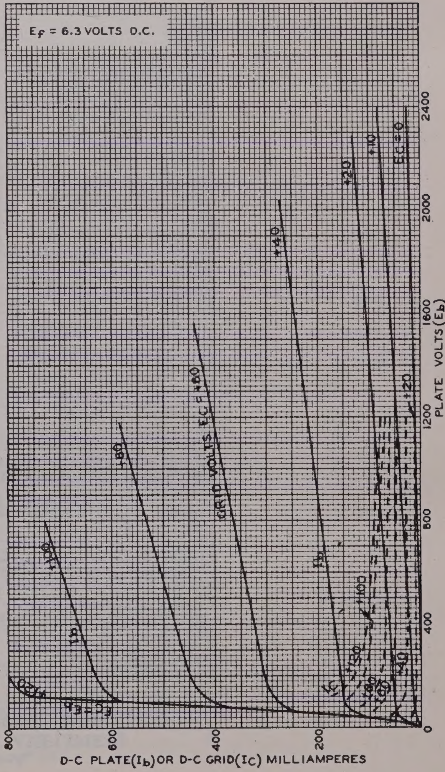
OPERATION CHARACTERISTICS



92C-6078R1

811

AVERAGE PLATE CHARACTERISTICS



811

TRANSMITTING TRIODE

Filament	Thoriated Tungsten	
Voltage	6.3	a-c or d-c volts
Current	4	amp.
Amplification Factor	160	
Direct Interelectrode Capacitances:		
Grid to Plate	5.5	μμf
Grid to Filament	5.5	μμf
Plate to Filament	0.6	μμf
Maximum Overall Length		6-9/16"
Maximum Diameter		2-7/16"
Bulb		ST-19
Cap		Medium Metal
Base		Medium 4-Pin,"Micanol" Bayonet
RCA Socket		UR-542-A

MAXIMUM CCS and ICAS RATINGS
with TYPICAL OPERATING CONDITIONS

CCS = Continuous Commercial Service
ICAS = Intermittent Commercial and Amateur Service

A-F POWER AMPLIFIER & MODULATOR – Class B

	CCS	*ICAS*	
D-C Plate Voltage	1250 max.	1500 max.	volts
Max.-Sig. D-C Plate Current*	125 max.	125 max.	ma.
Max.-Sig. Plate Input*	125 max.	150 max.	watts
Plate Dissipation*	40 max.	50 max.	watts
Typical Operation:			
Unless otherwise specified, values are for 2 tubes			
D-C Plate Voltage	1250	1500	volts
D-C Grid Voltage #	0	-9	volts
Peak A-F Grid-to-Grid Volt.	140	160	volts
Zero-Sig. D-C Plate Current	48	20	ma.
Max.-Sig. D-C Plate Current	200	200	ma.
Max.-Sig. D-C Grid Current	38	38	ma.
Load Resistance (per tube)	3750	4500	ohms
Effective Load Resistance (plate to plate)	15000	18000	ohms
Max.-Sig. Driving Power	3.8 approx.	4.2 approx.	watts
Max.-Sig. Power Output	175 approx.	225 approx.	watts

* Averaged over any audio-frequency cycle of sine-wave form.

R-F POWER AMPLIFIER – Class B Telephony

Carrier conditions per tube for use with a max. modulation fact. of 1.0

	CCS	*ICAS*	
D-C Plate Voltage	1250 max.	1500 max.	volts
D-C Plate Current	60 max.	60 max.	ma.
Plate Input	60 max.	75 max.	watts
Plate Dissipation	40 max.	50 max.	watts
Typical Operation:			
D-C Plate Voltage	1250	1500	volts

# See next page.

811

TRANSMITTING TRIODE

(continued from preceding page)

	CCS	*ICAS*	
Peak R-F Grid Voltage	180	225	volts
D-C Plate Current	125	150	ma.
D-C Grid Current**	35 approx.	35 approx.	ma.
Driving Power**	7 approx.	8 approx.	watts
Power Output	115 approx.	170 approx.	watts

** Subject to wide variations as explained on sheet TRANS. TUBE RATINGS.

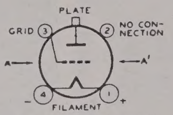
HIGH-FREQUENCY OPERATION

Maximum permissible percentage of maximum rated plate voltage and plate input.

FREQUENCY (Mc)	60	80	100
TELEPHONY {Class B	100	90	83
TELEPHONY {Class C, Plate Mod.	100	75	60
TELEGRAPHY – Class C	100	75	60

OUTLINE DIMENSIONS for the 811 are the same as those for the 809.

TOP VIEW OF SOCKET CONNECTIONS



AA'=PLANE OF ELECTRODES

MOUNTING POSITION
VERTICAL: Base down.
HORIZONTAL: Plane of electrodes vertical.

813

TRANSMITTING BEAM POWER AMPLIFIER

Filament	Thoriated Tungsten		
Voltage	10.0		a-c or d-c volts
Current	5		amp.
Transconductance for plate current of 50 ma.	3750 approx.		μmhos
Direct Interelectrode Capacitances:			
Grid to Plate (with external shielding)	0.2 max.		μμf
Input	16.3		μμf
Output	14		μμf
Maximum Overall Length			7-1/2"
Maximum Diameter			2-9/16"
Bulb			T-20
Cap			Medium Metal
Base			Giant 7-Pin, Bayonet
RCA Socket			Type UT-104

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

R-F POWER AMPLIFIER - Class B Telephony

Carrier conditions per tube for use with a max. modulation fact. of 1.0

D-C Plate Voltage	2000 max.		volts
D-C Screen Voltage (Grid #2)	400 max.		volts
D-C Plate Current	100 max.		ma.
Plate Input	150 max.		watts
Screen Input	15 max.		watts
Plate Dissipation	100 max.		watts
Typical Operation:			
D-C Plate Voltage	1500	2000	volts
D-C Screen Voltage	400	400	volts
D-C Grid Voltage (Grid #1)●	-60	-75	volts
Peak R-F Grid Voltage	70	80	volts
Beam-Forming Plate Voltage*	0	0	volts
D-C Plate Current	100	75	ma.
D-C Screen Current	4	3	ma.
D-C Grid Current ●	-	-	approx.ma.
Driving Power ○ ▲	-	-	approx.watt
Power Output	50	50	approx.watts

● Usually negligible. Fixed supply or by-passed cathode-resistor bias recommended.
▲ Usually negligible. Never more than 2 watts.

GRID-MODULATED R-F POWER AMPLIFIER - Class C Telephony

Carrier conditions per tube for use with a max. modulation fact. or 1.0

D-C Plate Voltage	2000 max.		volts
D-C Screen Voltage (Grid #2)	400 max.		volts
D-C Grid Voltage (Grid #1)	-200 max.		volts
D-C Plate Current	100 max.		ma.
Plate Input	150 max.		watts
Screen Input	15 max.		watts
Plate Dissipation	100 max.		watts
Typical Operation:			
D-C Plate Voltage	1500	2000	volts
D-C Screen Voltage	400	400	volts

●, *, ○: See end of tabulation.

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TRANSMITTING BEAM POWER AMPLIFIER

(continued from preceding page)

D-C Grid Voltage ●	-140	-120	volts
Peak R-F Grid Voltage	145	120	volts
Peak A-F Grid Voltage	60	60	volts
Beam-Forming Poate Voltage*	0	0	volts
D-C Plate Current	70	75	ma.
D-C Screen Current	3	3	ma.
D-C Grid Current ♠	-	-	approx.ma.
Driving Power ○ ▲	-	-	approx.watt
Power Output	40	50	approx.watts

♠ Usually negligible. Fixed supply or unby-passed cathode-resistor bias recommended.
▲ Usually negligible. Never more than 2 watts.

PLATE-MODULATED R-F POWER AMPLIFIER - Class C Telephony

Carrier conditions per tube for use with a max. modulation fact. of 1.0

D-C Plate Voltage	1600 max.		volts
D-C Screen Voltage (Grid #2)	400 max.		volts
D-C Grid Voltage (Grid #1)	-300 max.		volts
D-C Plate Current	150 max.		ma.
D-C Grid Current	25 max.		ma.
Plate Input	240 max.		watts
Screen Input	15 max.		watts
Plate Dissipation	67 max.		watts
Typical Operation:			
D-C Plate Voltage	1250	1600	volts
D-C Screen Voltage □	400	400	volts
D-C Grid Voltage † ●	-120	-130	volts
	30000	21600	ohms
Peak R-F Grid Voltage	195	210	volts
Beam-Forming Plate Voltage *	0	0	volts
D-C Plate Current	150	150	ma.
D-C Screen Current	16	20	ma.
D-C Grid Current	4	6	approx.ma.
Driving Power	0.7	1.2	approx.watts
Power Output	135	175	approx.watts

† Total effective grid-circuit resistance should not exceed 30000 ohms. Grid bias obtained by grid leak or by partial self-bias methods.
□ Obtained from fixed supply, modulated simultaneously with plate voltage.

R-F POWER AMPLIFIER & OSCILLATOR - Class C Telegraphy

Key-down conditions per tube without modulation ##

D-C Plate Voltage	2000 max.			volts
D-C Screen Voltage (Grid #2)	400 max.			volts
D-C Grid Voltage (Grid #1)	-300 max.			volts
D-C Plate Current	180 max.			ma.
D-C Grid Current	25 max.			ma.
Plate Input	360 max.			watts
Screen Input	22 max.			watts
Plate Dissipation	100 max.			watts
Typical Operation:				
D-C Plate Voltage	1250	1500	2000	volts

○, ●, *, **: See end of tabulation.

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TRANSMITTING BEAM POWER AMPLIFIER

(continued from preceding page)

D-C Screen Voltage §	300	300	400	volts
	42000	60000	107000	ohms
D-C Grid Voltage ★	-60	-70	-90	volts
	8500	11700	30000	ohms
Peak R-F Grid Voltage	145	150	160	volts
Beam-Forming Plate Voltage*	0	0	0	volts
D-C Plate Current	180	180	180	ma.
D-C Screen Current	23	20	15	ma.
D-C Grid Current	7	6	3	approx.ma.
Driving Power	1	0.8	0.5	approx.watt
Power Output	155	190	260	approx.watts

Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.
★ Obtained by grid leak or other self- or fixed-bias method.
§ Preferably obtained from separate source or potentiometer, although series resistor connected to plate supply may be used.
* Beam-forming plates should be connected to the mid-point of filament circuit operated on a.c., or to the negative end of filament operated on d.c.
● For a-c filament supply. If d.c. is used, the stated voltages should be decreased by 7 volts.
○ At crest of audio-frequency cycle with modulation factor of 1.0.

OPERATION AT HIGH FREQUENCIES

Maximum permissible percentage of maximum rated plate voltage and plate input

FREQUENCY (Mc)		30	45	60	120
TELEPHONY	Class B	100%	93%	88%	76%
	Class C Grid Mod.	100	93	88	76
	Class C Plate Mod.	100	87	75	50
TELEGRAPHY - Class C		100	87	75	50

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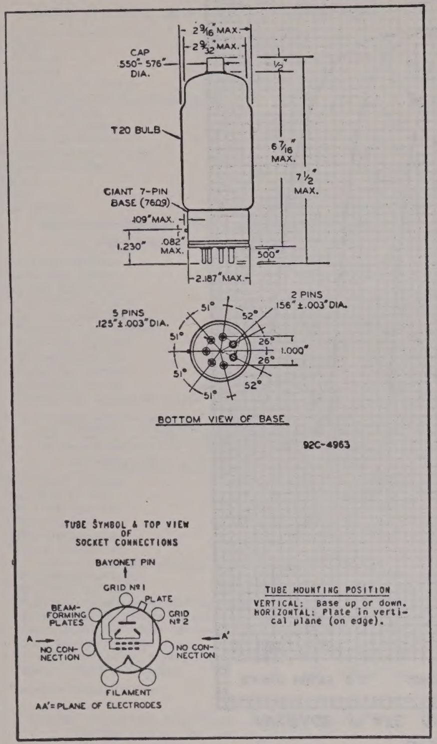
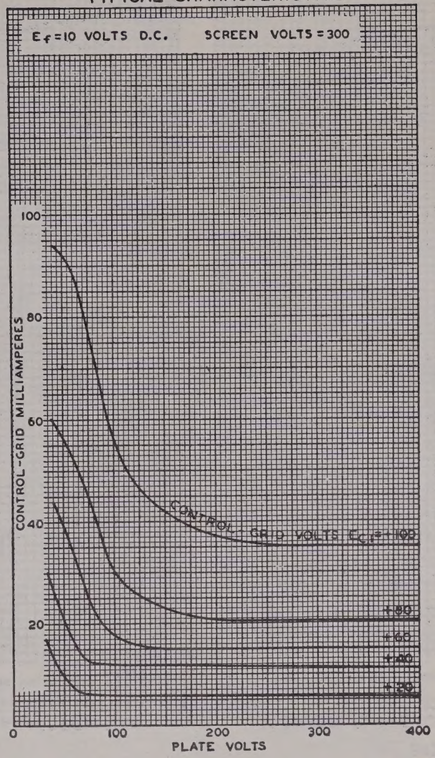
TRANSMITTING BEAM POWER AMPLIFIER



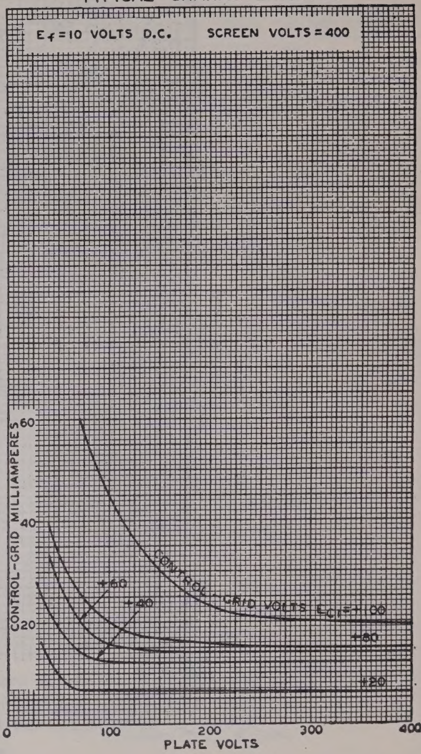
TUBE MOUNTING POSITION

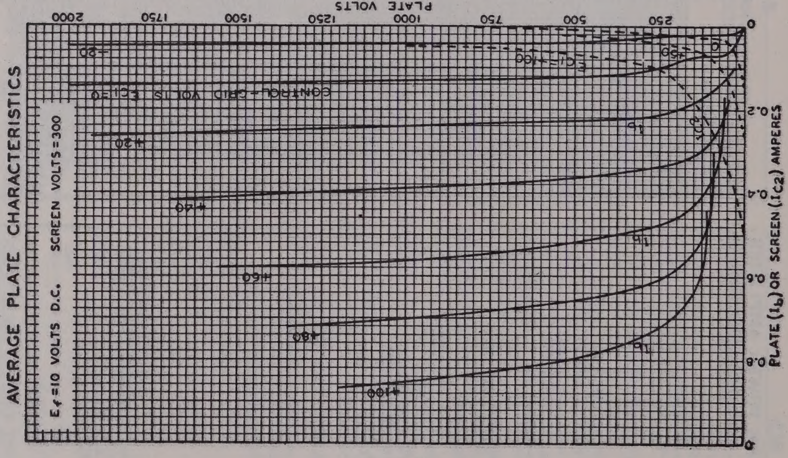
VERTICAL: Base up or down.
HORIZONTAL: Plate in vertical plane (on edge).

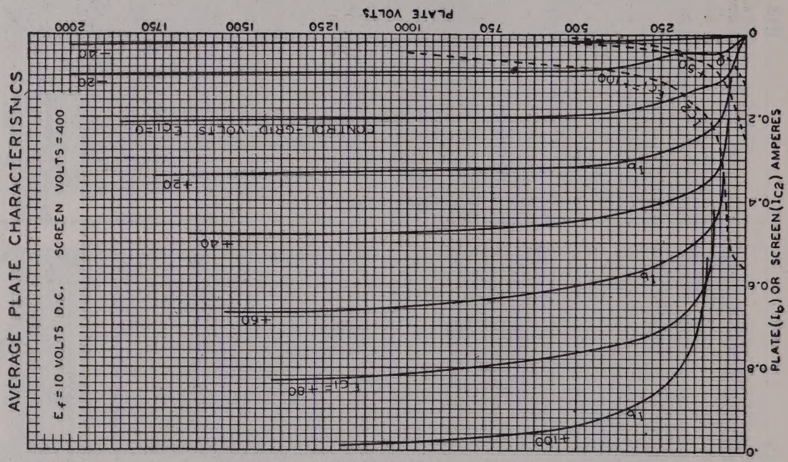
813
TYPICAL CHARACTERISTICS



813
TYPICAL CHARACTERISTICS




813
AVERAGE PLATE CHARACTERISTICS
E_f=10 VOLTS D.C. SCREEN VOLTS=300
PLATE VOLTS
0
250
500
750
1000
1250
1500
1750
2000
PLATE (I_b) OR SCREEN (I_C2) AMPERES
0.2
0.4
0.6
0.8
CONTROL-GRID VOLTS E_C1=0
-20
+20
+40
+60
+80
+100
E_C1=+100
+50
0
I_b
I_C2


813
AVERAGE PLATE CHARACTERISTICS
E_f=10 VOLTS D.C. SCREEN VOLTS=400
PLATE VOLTS
0
250
500
750
1000
1250
1500
1750
2000
PLATE (I_b) OR SCREEN (I_C2) AMPERES
0.2
0.4
0.6
0.8
CONTROL-GRID VOLTS E_C1=0
-40
-20
+20
+40
+60
E_C1=+80
+100
E_C1=+100
+50
0
I_b
I_C2

845

MODULATOR, A-F POWER AMPLIFIER

Filament	Thoriated Tungsten	
Voltage	10	a-c or d-c volts
Current	3.25	amp.
Amplification Factor	5.3	
Direct Interelectrode Capacitances:		
Grid to Plate	13.5	μμf
Grid to Filament	6	μμf
Plate to Filament	6.5	μμf
Maximum Overall Length		7-7/8"
Maximum Diameter		2-5/16"
Bulb		T-18
Base		Jumbo 4-Large Pin
RCA Socket		Type UT-541 ←

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

A-F POWER AMPLIFIER & MODULATOR - Class A_1

D-C Plate Voltage			1250 max.	volts
Plate Dissipation			100 max.	watts ←
Typical Operation:				←
D-C Plate Voltage	750	1000	1250	volts
D-C Grid Voltage*	-98	-145	-195	volts
Peak A-F Grid Voltage	93	140	190	volts
D-C Plate Current	95	90	80	ma.
Transconductance	3100	3100	3100	μmhos
Plate Resistance	1700	1700	1700	ohms
Load Resistance	3400	6000	11000	ohms
U.P.O. (5% second harmonic)	15	24	30	watts

NOTE: In cases where the input circuit to the 845 is resistance coupled, the resistance in the grid circuit should not exceed 0.5 megohm when cathode bias is used. Without cathode bias, the d-c resistance in the grid-coupling circuit should not exceed 0.1 megohm.

A-F POWER AMPLIFIER & MODULATOR - Class AB_1 ←

D-C Plate Voltage		1250 max.	volts
D-C Grid Voltage		-400 max.	volts
D-C Plate Current		120 max.	ma.
Plate Input		150 max.	watts
Plate Dissipation		100 max.	watts
Typical Operation.			
Unless otherwise specified, values are for 2 tubes			
D-C Plate Voltage	1000	1250	volts
D-C Grid Voltage*	-175	-225	volts
Peak A-F Grid-to-Grid Voltage	340	440	volts
Zero-Signal D-C Plate Current	40	40	ma.
Max.-Signal D-C Plate Current	230	240	ma.
Load Resistance (per tube)	1150	1650	ohms
Effective Load Res. (plate to plate)	4600	6600	ohms
Max.-Signal Power Output	75	115	approx. watts

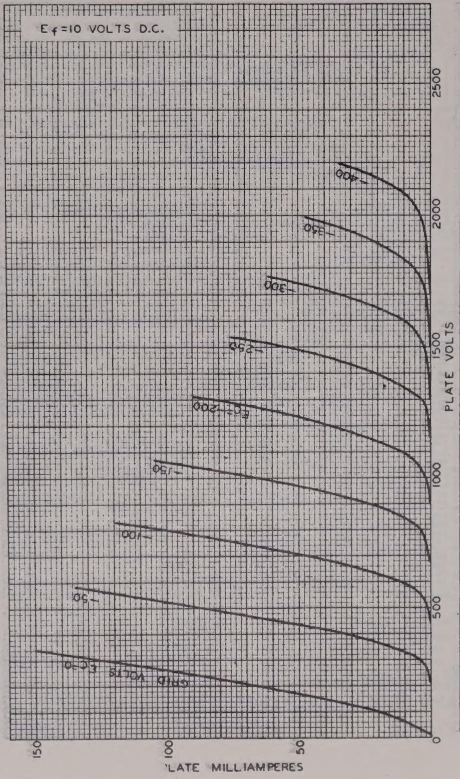
* With a-c filament supply.

OUTLINE DIMENSIONS, TUBE SYMBOL, and SOCKET CONNECTIONS for the 845 are the same as for the 211.

← Indicates a change.

845

AVERAGE PLATE CHARACTERISTICS



211

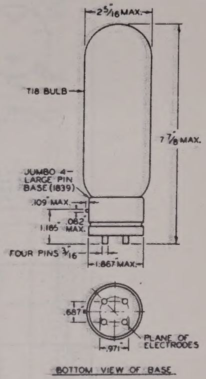
R-F POWER AMPLIFIER, OSCILLATOR, A-F POWER AMPLIFIER, MODULATOR

(continued from preceding page)

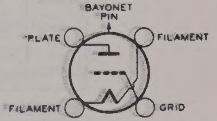
° At crest of a-f cycle with modulation factor of 1.0.

°° Subject to wide variations as explained on sheet TRANS. TUBE RATINGS.

For use of the 211 at the higher frequencies, refer to sheet TRANS. TUBE RATINGS vs FREQUENCY.



TUBE SYMBOL & TOP VIEW OF SOCKET CONNECTIONS



866-A/866

HALF-WAVE MERCURY VAPOR RECTIFIER

This type supersedes RCA Types 866 and 866-A

Filament*	Coated	
Voltage	2.5	a-c volts
Current	5.0	amp.
Maximum Overall Length		6-5/8"
Maximum Diameter		2-7/16"
Bulb		ST-19
Cap		Medium Metal, with Insulating Collar
Base		Medium 4-Pin, Bayonet
RCA Socket		UR-542A

MAXIMUM RATINGS

	Column I	Column II	
Peak Inverse Voltage:			
For supply frequency up to 150~			
Cond. Mercury Temp. 25° to 60°C#	-	10000 max.	volts
Cond. Mercury Temp. 25° to 70°C#	200 max.	-	volts
For supply frequency up to 1000~			
Cond. Mercury Temp. 25° to 70°C#	-	5000 max.	volts
Peak Plate Current	2.0 max.	1.0 max.	amp.
Average Plate Current	0.5 max.	0.25 max.	amp.
Tube Voltage Drop (Approx.)	15	15	volts

* The filament of the 866-A/866 is partially shielded from the plate to permit operation from a power supply having a frequency up to 1000 cycles per second. The filament should be allowed to come up to operating temperature before plate voltage is applied. For average conditions, the delay is approximately 30 seconds.

# Operation at 40° ± 5°C is recommended.

For *shielding* and *r-f filter circuits*, refer to Type 871.

NOTES ON COLUMN II

The table on the next page gives empirical values of choke inductance (L) and the condenser capacitance (C) for choke-input-to-filter circuits which will keep the peak plate current below the recommended maximum, provided the average d-c load current does not exceed the maximum load-current values shown. Values of (L) and (C) are based on a 60-cycle a-c voltage supply.

The capacitance (C) is small enough to prevent excessive surges when power is first applied to the circuit, and yet large enough to give adequate filtering. If the inductance (L) is increased, it is permissible to increase the capacitance in the same proportion. In a two-section filter with two inductances of unequal value, the larger inductance should be placed next to the rectifier tubes. With such an arrangement, the maximum value of each capacitance should be determined on the basis of the value of the inductance preceding it.

The circuits (see Type 872) of Figs. 1, 2, and 3 will give a ripple voltage less than 5% when used with a two-section filter having the minimum of inductance and the corresponding maximum of capacitance. The circuits of Figs. 4 and 5 will give a ripple voltage of less than 1%. For any of these circuits, better filtering may be obtained with the inductances larger than the minimum given in the table. For these larger inductances, the corresponding capacitances may be increased by the same percentage as the inductances to give still better results.

866-A/866

HALF-WAVE MERCURY VAPOR RECTIFIER

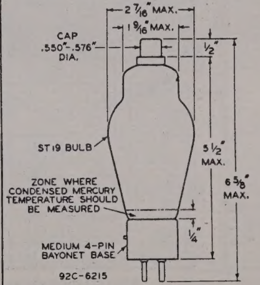
For Circuits, refer to Type 872.

(continued from preceding page)

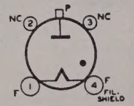
CIRCUIT	A-C INPUT VOLTS** (RMS)	MAX. D-C OUTPUT VOLTS TO FILTER	CHOKE INPUT ONE-SECTION FILTER		MAX. D-C LOAD CURRENT
			MIN. CHOKE (L) Henrys	MAX. CONDENSER (C) μf	amperes
SINGLE-PHASE FULL-WAVE (2 tubes) FIG.1	3535 per tube 3000 " " 2000 " " 1500 " "	3180 2700 1800 1350	8.0 6.8 4.5 3.4	1.25 1.5 2.1 2.8	0.5 0.5 0.5 0.5
SINGLE-PHASE FULL-WAVE (4 tubes) FIG.2	7070 total 6000 " 5000 " 4000 "	6360 5400 4500 3600	16.0 13.5 11.0 8.9	0.6 0.7 0.9 1.1	0.5 0.5 0.5 0.5
THREE-PHASE HALF-WAVE FIG.3	4080 per leg 3000 " " 2000 " " 1500 " "	4780 3510 2340 1750	3.2 2.2 1.4 1.1	1.4 2.0 3.0 4.0	0.75 0.75 0.75 0.75
THREE-PHASE DOUBLE-Y PARALLEL FIG.4	4080 per leg 3000 " " 2000 " " 1500 " "	4780 3510 2340 1750	2.0 1.5 1.0 0.7	0.5 0.7 1.1 1.5	1.5 1.5 1.5 1.5
THREE-PHASE FULL-WAVE FIG.5	4080 per leg 3000 " " 2000 " " 1500 " "	9570 7020 4680 3510	1.8 1.4 0.9 0.7	0.5 0.7 1.2 1.5	0.75 0.75 0.75 0.75
SINGLE-PHASE FULL-WAVE (2 tubes) FIG.1*	3535 per tube 3000 " " 2000 " " 1500 " "	3950 3390 2260 1700	- - - -	- - - -	0.25 0.25 0.25 0.25

* With condenser input to filter.

** For use under the conditions of the 10000-volt peak inverse rating. If the 866-A/866 is to be used under frequency and/or temperature conditions such that the peak inverse voltage is limited to 5000 volts, the a-c input voltage and d-c output voltage values in the table should be multiplied by a factor of 0.5 to give new values for the 5000-volt conditions



BOTTOM VIEW OF SOCKET CONNECTIONS



Pin 1 - Filament
Pin 2 - No Connection
Pin 3 - No Connection
Pin 4 - Filament
Cap - Plate
● - Gas Tube Type

TUBE MOUNTING POSITION

VERTICAL: Base down.
HORIZONTAL: No.

872-A/872

HALF-WAVE MERCURY-VAPOR RECTIFIER

This Type Supersedes RCA Types 872 and 872-A

Filament*	Coated	
Voltage	5.0	a-c volts
Current	7.5	amp.
Maximum Overall Length		8-1/2"
Maximum Diameter		2-5/16"
Bulb		T-18
Cap	Medium Metal, with Insulating Collar	
Base°		Jumbo 4-Large Pin
RCA Socket (Type UT-541-A)		Stock No.9936

Maximum Ratings Are Absolute Values

MAXIMUM RATINGS

Peak Inverse Voltage		
For Supply Frequency up to 150 ~		
Cond.-Mercury Temp. 20° to 60°C #	10000 max.	volts
Cond.-Mercury Temp. 20° to 70°C #	5000 max.	volts
Peak Plate Current	5 max.	amp.
Average Plate Current	1.25 max.	amp.
Tube Voltage Drop (Approx.)	10	volts

° Base shell is not connected within the base to either filament lead.

Operation at 40° ± 5°C is recommended.

* The filament of the 872-A/872 should be allowed to come up to operating temperature before plate voltage is applied. For average conditions the delay is approximately 30 seconds.

If the plate return of each tube is not connected to the center-tap of the filament-supply winding, the return should be made to that side of the filament to which the cathode shield is connected.

Shielding and *r-f filter circuits* should be isolated from the transmitter as much as possible in order to avoid the detrimental effects of magnetic and electrostatic fields. These fields tend to produce breakdown in the mercury vapor, are detrimental to tube life and make filtering difficult. External shielding should be used when the tubes are in proximity to these external fields. R-f filtering should be used when the tubes are affected by r-f voltages. When shields are used, special attention must be given to adequate ventilation and to the maintenance of normal condensed-mercury temperature.

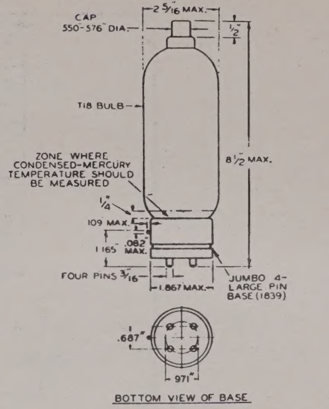
The table below classifies suitable rectifier circuits for the 872-A/872 and shows their safe maximum input and maximum output operating conditions for a peak inverse voltage of 10000 volts. The values are based on sine-wave input and the use of a suitable choke preceding any condenser in the filter circuit. If the 872-A/872 is to be used under temperature conditions such that the peak inverse voltage is limited to 5000 volts, the a-c input voltage and d-c output voltage values in the table should be multiplied by a factor of 0.5 to give the maximum values for the 5000-volt conditions.

CIRCUIT	MAXIMUM A-C INPUT VOLTS□ (RMS)	APPROX. D-C OUTPUT VOLTS TO FILTER	MAX. D-C OUTPUT CURRENT amperes
SINGLE-PHASE FULL-WAVE (2 tubes) Fig. 1	3535 per tube	3180	2.5
SINGLE-PHASE FULL-WAVE (4 tubes) Fig. 2	7070 total	6360	2.5
THREE-PHASE HALF-WAVE Fig. 3	4080 per leg	4780	3.75
THREE-PHASE DOUBLE-Y PARALLEL Fig. 5	4080 per leg	4780	7.5
THREE-PHASE FULL-WAVE Fig. 5	4080 per leg	9570	3.75

□ For maximum peak inverse voltage of 10000 volts.

872-A/872

HALF-WAVE MERCURY-VAPOR RECTIFIER



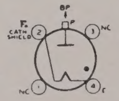
BOTTOM VIEW OF BASE

92C-6396

TUBE MOUNTING POSITION
VERTICAL. Base down.
HORIZONTAL: No.

BOTTOM VIEW OF SOCKET CONNECTIONS

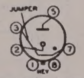
Pin 1 – No Connection
Pin 2 – Filament, Cathode Shield
Pin 3 – No Connection
Pin 4 – Filament
Cap – Plate
● – Gas Type Tube



VR150-30

VOLTAGE REGULATOR

Type	Glow Discharge
Maximum Overall Length	4-1/8"
Maximum Seated Height	3-9/16" ←
Maximum Diameter	1-9/16"
Bulb	ST-12
Base	Small Shell Octal 6-Pin



Pin 1 - No Connection
Pin 2 - Cathode
Pin 3 - Jumper #
Pin 5 - Anode
Pin 7 - Jumper #
Pin 8 - No Connection

BOTTOM VIEW

Mounting Position	Any ←

Maximum and Minimum Ratings Are Absolute Values

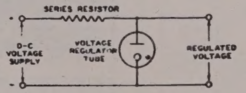
Operating Conditions:

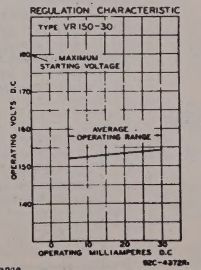
Starting Supply-Voltage	180 min. d-c volts
Operating Voltage (approx.)	150 d-c volts
Operating Current •	5 min. d-c ma. 30 max. d-c ma.

# With suitable socket connections, jumper within base acts as switch to open power-supply circuit when voltage regulator tube is removed from socket

• Sufficient resistance must always be used in series with the tube to limit the current through it to 30 ma.

OUTLINE DIMENSIONS for the VR150-30 are the same as those for Type 884





← Indicates a change.

SUPPLEMENTARY DRAWINGS

The drawings contained in this envelope are enlarged duplicates of illustrations bound in this book.

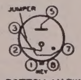
REPLACE ALL DRAWINGS AFTER USE

VR150-30

VOLTAGE REGULATOR

Type	Glow Discharge
Maximum Overall Length	4-1/8"
Maximum Seated Height	3-9/16" ←
Maximum Diameter	1-9/16"
Bulb	ST-12
Base	Small Shell Octal 6-Pin

Pin 1 - No Connection
Pin 2 - Cathode
Pin 3 - Jumper #
Pin 5 - Anode
Pin 7 - Jumper #
Pin 8 - No Connection



BOTTOM VIEW

Mounting Position	Any ←

Maximum and Minimum Ratings Are Absolute Values

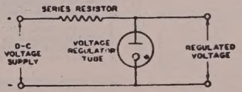
Operating Conditions:

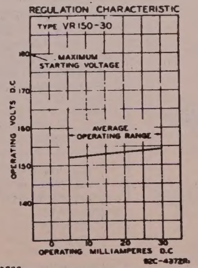
Starting Supply-Voltage	180 min. d-c volts
Operating Voltage (approx.)	150 d-c volts
Operating Current •	5 min. d-c ma. 30 max. d-c ma.

# With suitable socket connections, jumper within base acts as switch to open power-supply circuit when voltage regulator tube is removed from socket

• Sufficient resistance must always be used in series with the tube to limit the current through it to 30 ma.

OUTLINE DIMENSIONS for the VR150-30 are the same as those for Type 884





← Indicates a change.

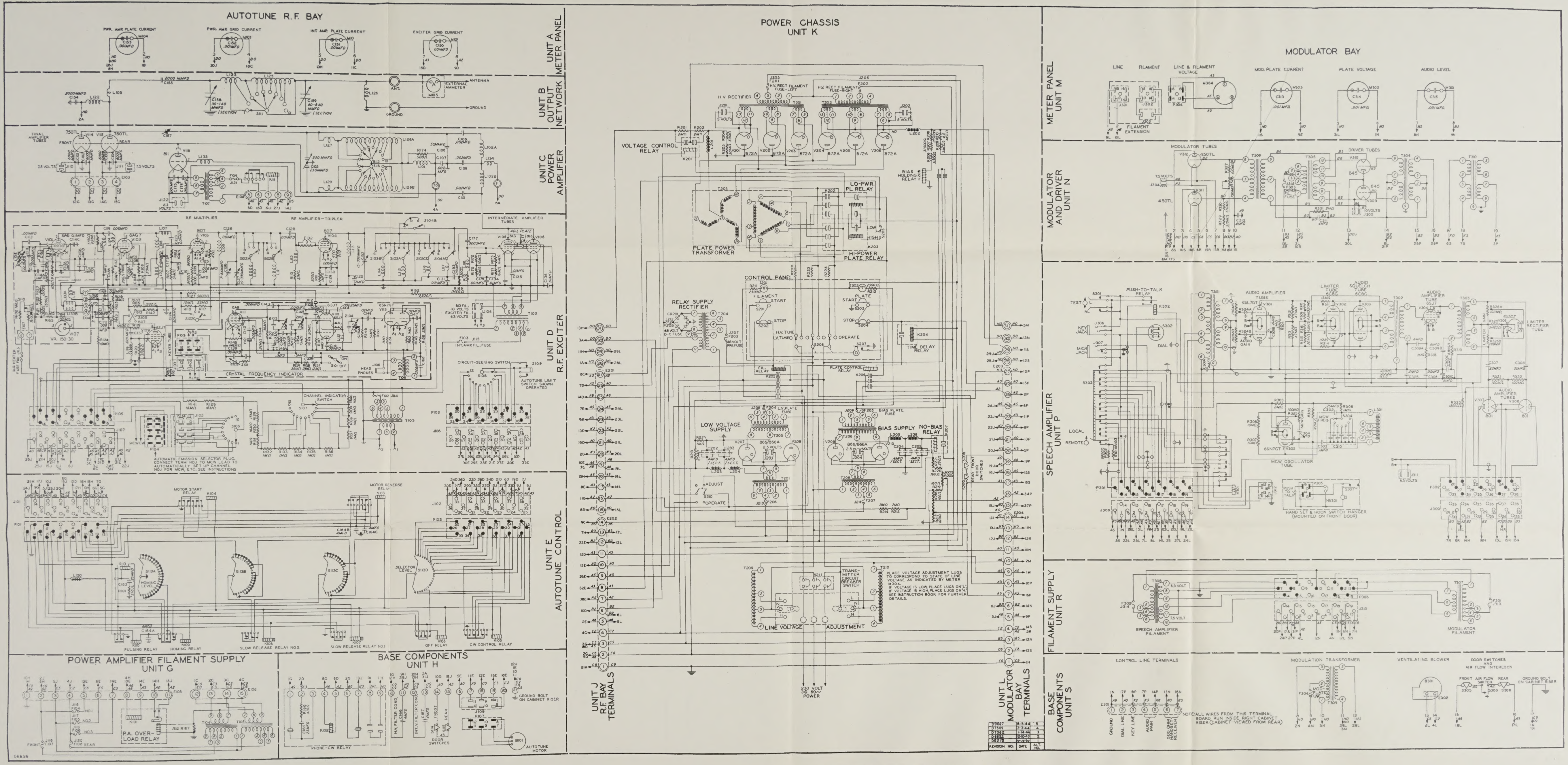


FIGURE No. 129 TDH CABLING SCHEMATIC DIAGRAM (Dwg. No. 500 0512 00F)

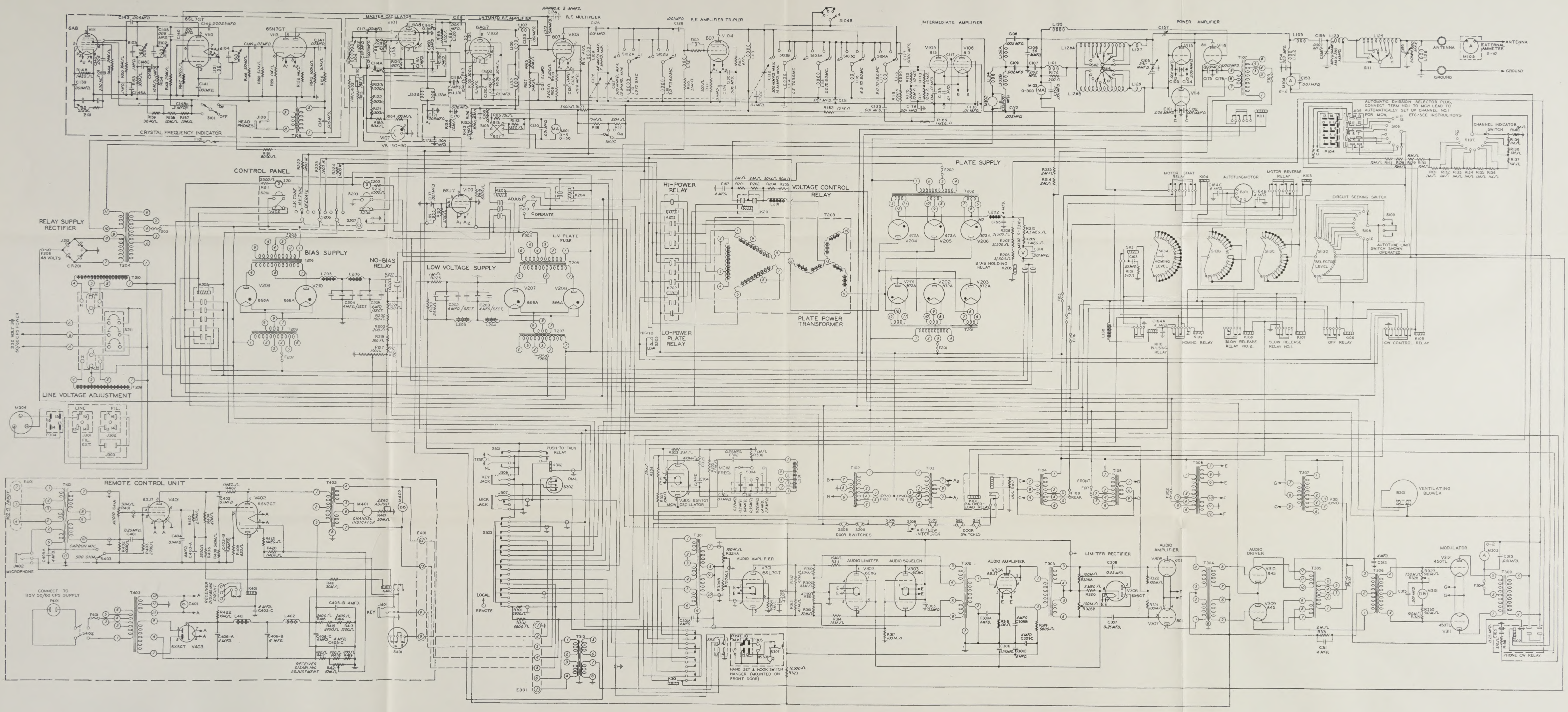


FIGURE No. 128 TDH COMPLETE SCHEMATIC DIAGRAM (Dwg. No. 500 3719 00F)